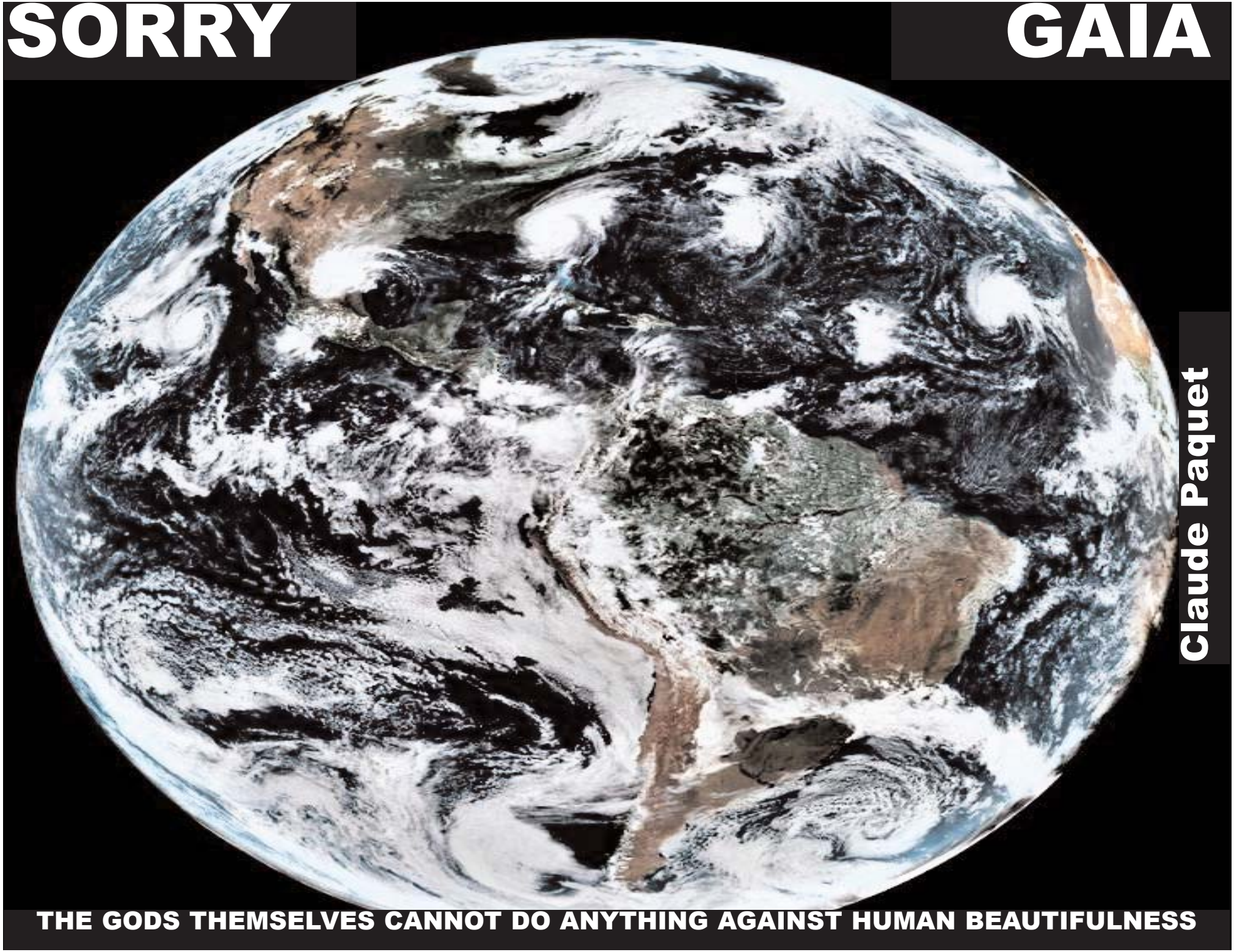
SORRY GAIA



Claude Paquet

THE GODS THEMSELVES CANNOT DO ANYTHING AGAINST HUMAN BEAUTIFULNESS

Who is Gaia?
Gaia is first and foremost the famous goddess of Greek mythology. Gaia, the Earth, is named immediately after Chaos and immediately before Eros. Eight centuries before Christ, Hesiod sang of Gaïa, Mother Earth "wide-breasted, forever unshakable residence of all beings". This goddess is nature, self-fertilizes and constantly recreates the universe from its own essence. This figure illustrates rather well the cult of the goddess which draws its essence from Paleolithic traditions and their Venuses. Let us add that this figure, these cults are increasingly linked to other conceptions of Mother Earth, those of the Amerindians, that of the Pachamama.

The Earth is more than just a rocky sphere, James Lovelock (b. 1919) tells us. It is a superior organization, capable of self-regulation.

Lovelock's hypothesis
The Gaia hypothesis postulates that the Earth's atmosphere is maintained and actively regulated by the life evolving on its surface, ie by the biosphere. The biosphere thus functions as a single organism within which each interaction contributes to the maintenance of life.

"All living beings on Earth - from whales to viruses, from oaks to algae - can be considered as forming a single living entity, capable of manipulating the atmosphere of the Earth in such a way as to satisfy its general needs and endowed with faculties and powers greater than those of its constituent parts," writes Lovelock. A contast that is consistent with the origin of the atmosphere and all life on Earth.

Considering Gaia in this way invites us to rethink the foundations of our relationship to nature and ecology. This vision of a co-evolution with other beings, it is now allowed, even recommended, to consider the Earth and its inhabitants as partners (and not as competitors or worthless beings). The theory questions the foundations of the Promethean and anthropocentric attitude. It is an alternative to this pessimistic vision which sees in nature a primitive force to be dominated and conquered.

The principle of homeostasis
"The most important property of Gaia is its tendency to optimize the conditions of all terrestrial life (…) We have defined Gaia as a complex entity comprising the terrestrial biosphere, the atmosphere, the oceans and the earth; the whole constituting a feedback or cybernetic system that seeks an optimal physical and chemical environment for life on this planet. The preservation of relatively constant conditions through active control could be satisfactorily described by the term 'homeostasis'," writes Lovelock.

The concept of homeostasis - invented by the American physiologist Walter Cannon - refers to this remarkable state of constancy in which living beings maintain themselves when their environment changes. The operation of homeostasis, whether in the case of a cell, an animal or the whole of the biosphere, takes place for the most part automatically, yet it must be admitted that a form some intelligence is needed even within an automatic process to correctly interpret the information gathered about the environment.

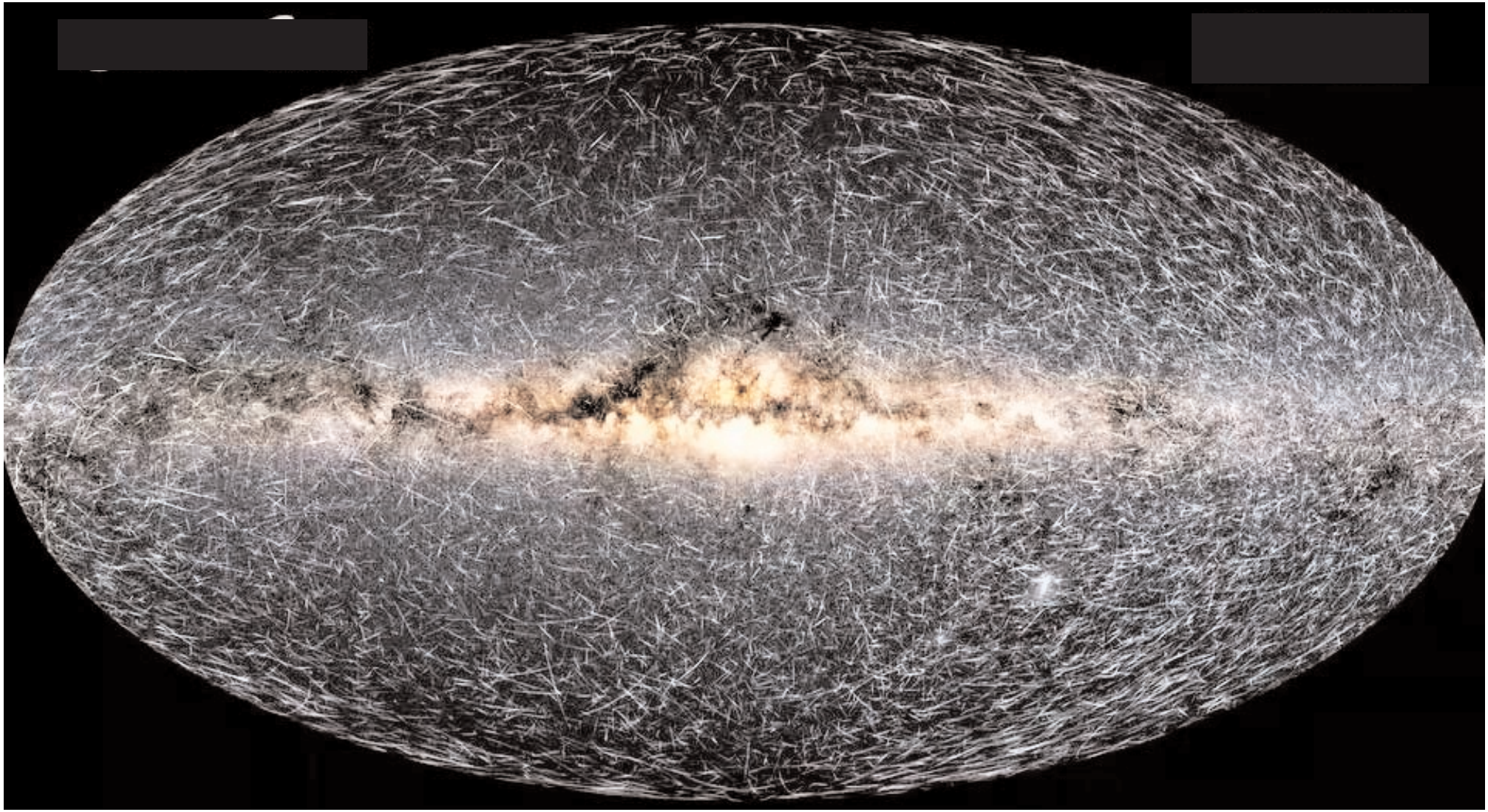
The question of human becoming
Gaïa invites us to modesty, to critical overcoming of our tendency to anthropocentrism. Humanity has significantly altered some of the planet's most important chemical cycles, causing unpredictable chain reactions. Certainly Gaia is not in danger, but in the new balance that would result from a major disturbance, humanity would not necessarily find its place.

A homeostatic system forgives many deviations from its balanced state, but only as long as it remains within its regulatory capabilities; too close to its limits it runs the risk, faced with a large-scale disturbance, of jumping to a new stable state very different from the previous one, or even of disintegrating. Pollution, changes in land use methods or changes in the ecology of continental shelves could thus trigger disasters on a planetary scale. The regulation of the Earth's climate is perhaps very close to one of its limits.

The important thing for a scientific theory is not that it is right, if we follow Karl Popper we can only prove its falsity, but that it is useful.

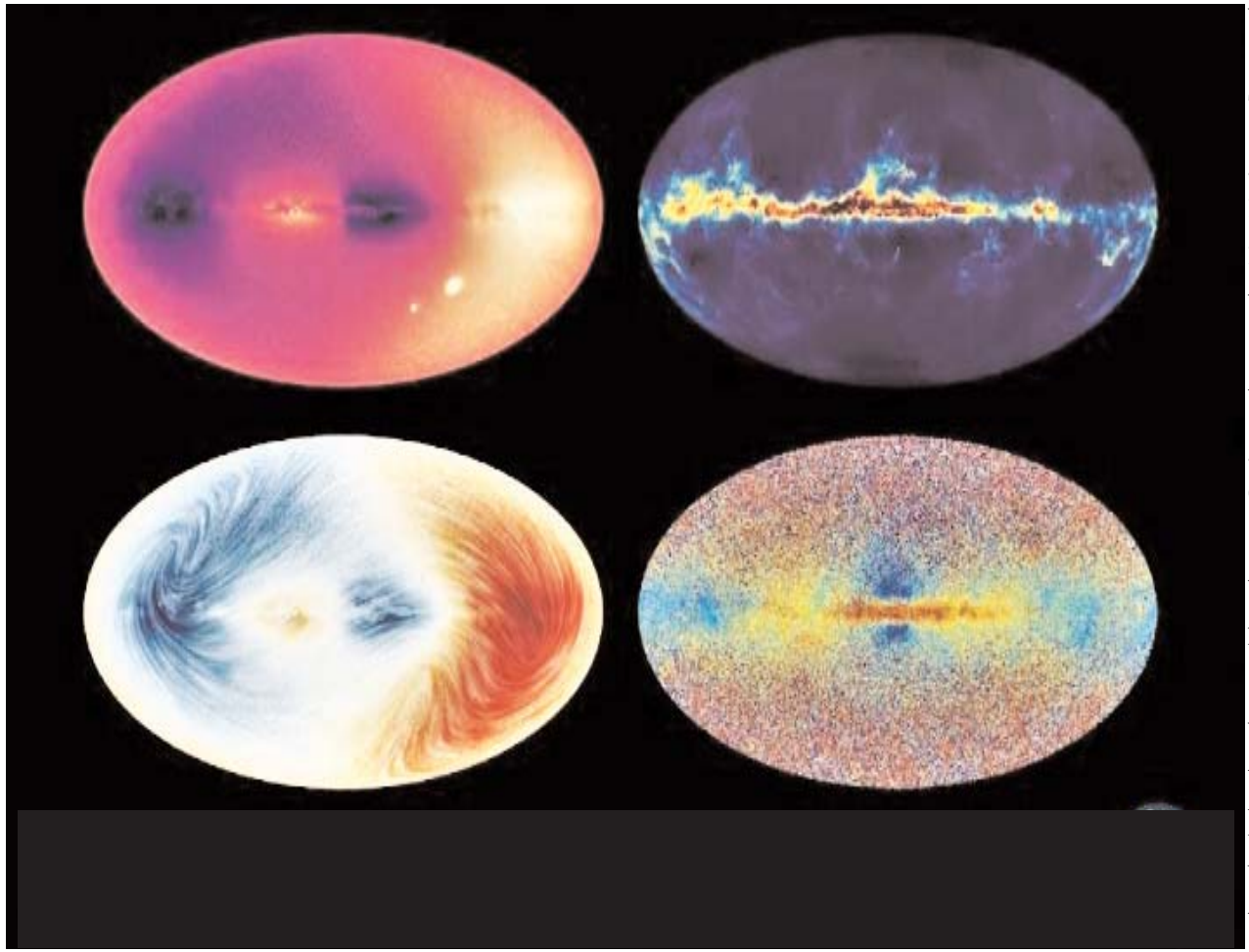
Unfortunately, we do not yet know how to answer the questions that Gaia suggests: how stable is the current system? Any civilization, in fact, which does not include in its concerns the respect of living conditions on Earth is doomed to disappear like a snowball in the sun.

The bets are therefore open on the chances of survival of man on the surface of the Earth at the dawn of the current globalization which is advancing ineluctably. Will we be able to adapt the technology on a large scale to biological needs? The life and survival of all humanity is at stake.



This map of the Milky Way shows a turbulent history and above all reveals a multitude of stellar currents, distributed throughout the Galaxy, which are so many clues and vestiges of its past tormented by brutal phenomena which contributed to its formation, for steps. These stellar currents, whose lifespan spans billions of years, are in a way the branches of the genealogical tree of the Galaxy. Branches that each correspond to a specific event that contributed to the formation of the Milky Way. They show stars that have been imported into the Milky Way from parent galaxies or star clusters. The composition of stars can tell us about their place of birth and their subsequent journey, and therefore about the history of the Milky Way.

The Gaia space telescope has just delivered (2022) its new data on nearly two billion stars in the Milky Way, with an unprecedented precision which makes it possible to draw up the map of our galaxy, bubbling with life. Equipped with two telescopes and a billion-pixel photographic sensor, Gaia scans a very small part (barely 1%) of the stars in our galaxy, whose diameter measures 100,000 light-years.



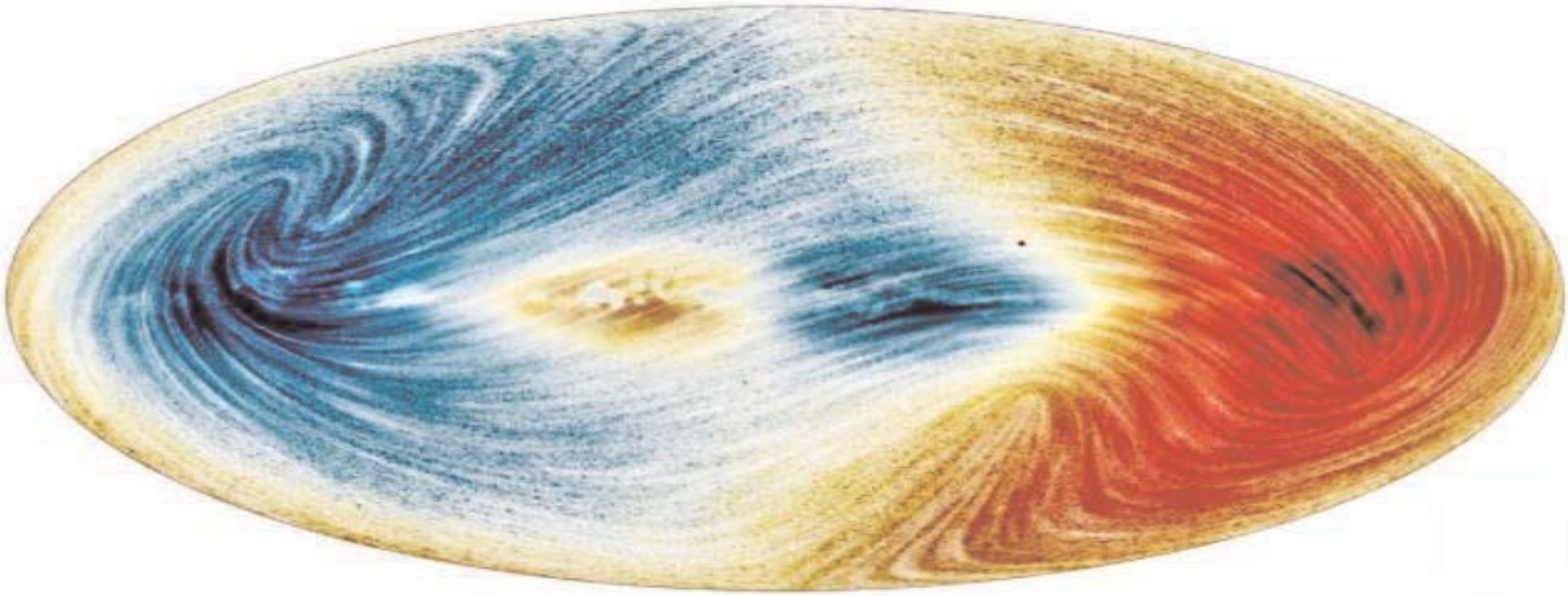
A host of unprecedented details are delivered, such as these 220 million photometric spectra, which will make it possible to estimate for the first time the mass, color, temperature and age of stars. And 2.5 million new chemical compositions, this "DNA" informing about the birthplace of stars, and their journey through the galaxy.

Or 35 million radial velocities, which measure the displacement of stars and offer a new understanding of the movements of the Milky Way.

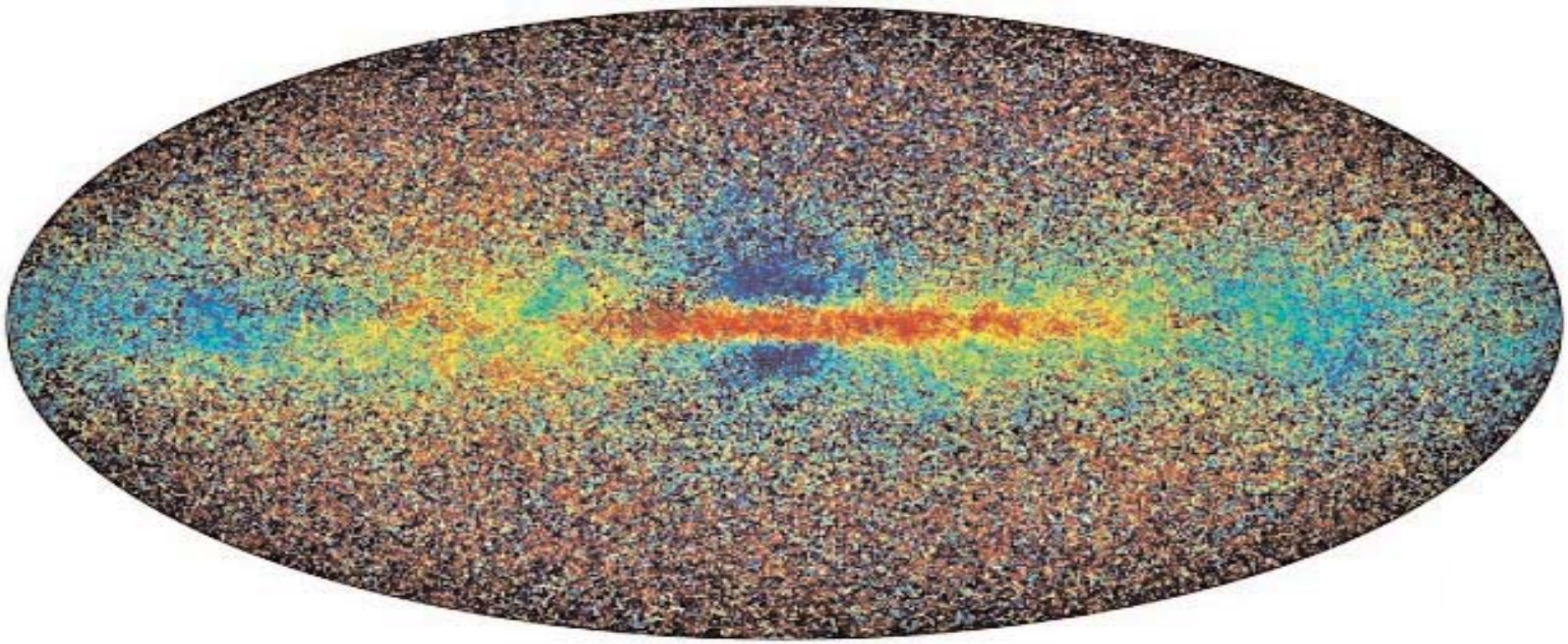
Surprise for scientists: Gaia has spotted for the first time stellar "tremors", tiny movements on the surface of a star that change its shape. The discovery opens "a goldmine for the 'asteroseismology' of massive stars", namely their inner workings.

The results, which gave rise to around fifty scientific articles in the process, paint the portrait of a galaxy "much more turbulent" than expected. Our galaxy is a magnificent melting pot of stars. It is also home to a very heterogeneous population of stars, some of which were not there from the outset but may have been "swallowed up" along the way through interactions with the nearby Sagittarius dwarf galaxy.

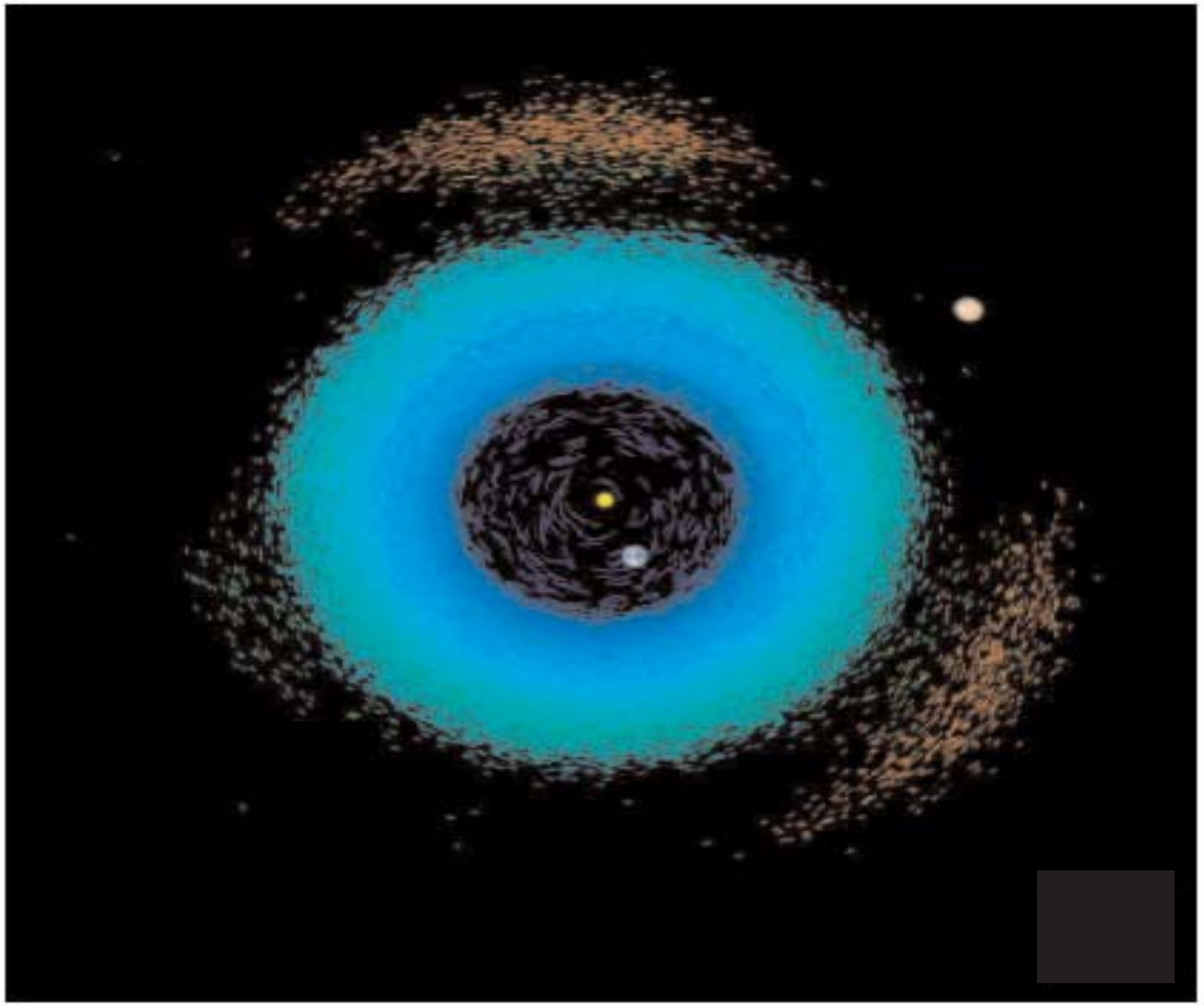
Gaia's level of precision is such that it will allow us to trace the past of the Milky Way over more than 10 billion years. Stars have the particularity of living for billions of years: analyzing them is the equivalent of studying a fossil, informing us about the state of the galaxy during its formation, underline the astronomers.



The moving Milky Way shows us the speed at which more than 30 million stars are approaching or moving away from us. This is called " radial velocity" and it provides the third dimension of velocity, we can see how stars move over a great distance. This sky map shows us the velocity field for about 26 million stars in the Milky Way. The colors represent the radial velocities along the line of sight. The colors represent different regions: blue indicates parts of the sky where the average motion of stars is moving towards us, and red shows regions moving away from us. The lines show us how direction varies with galactic latitude and longitude.



Chemical map of the Milky Way. The composition of stars can tell us about their places of birth and therefore about the history of the Milky Way. Colors indicate stellar metallicity. Red stars are metal-rich folds. We see that some stars in our galaxy are made of primordial matter, while others like our sun are made of enriched matter from previous generations. Stars closer to the center are richer in metals than stars at greater distances.



Position of each asteroid measured on June 13, 2022. Each asteroid is represented by a segment indicating its movement over 10 days. Internal bodies move faster around the Sun (yellow circle in the center) . Blue describes the inner part of the Solar System, where near-Earth asteroids, Mars cruisers and terrestrial planets are found. The main belt between Mars and Jupiter is green. The two orange clouds correspond to Jupiter's Trojan asteroids.

Water in the Universe

Multiple hypotheses have been put forward, each time challenged by new discoveries. But two theories are neck and neck and stand out. So, are our oceans the result of a primitive flood from the bowels of the Earth? Or is it of extraterrestrial origin?

The oceans cover 70% of the planet's surface and form a huge reservoir that acts as a very important regulator. We will examine three aspects of the regulatory role of the ocean.

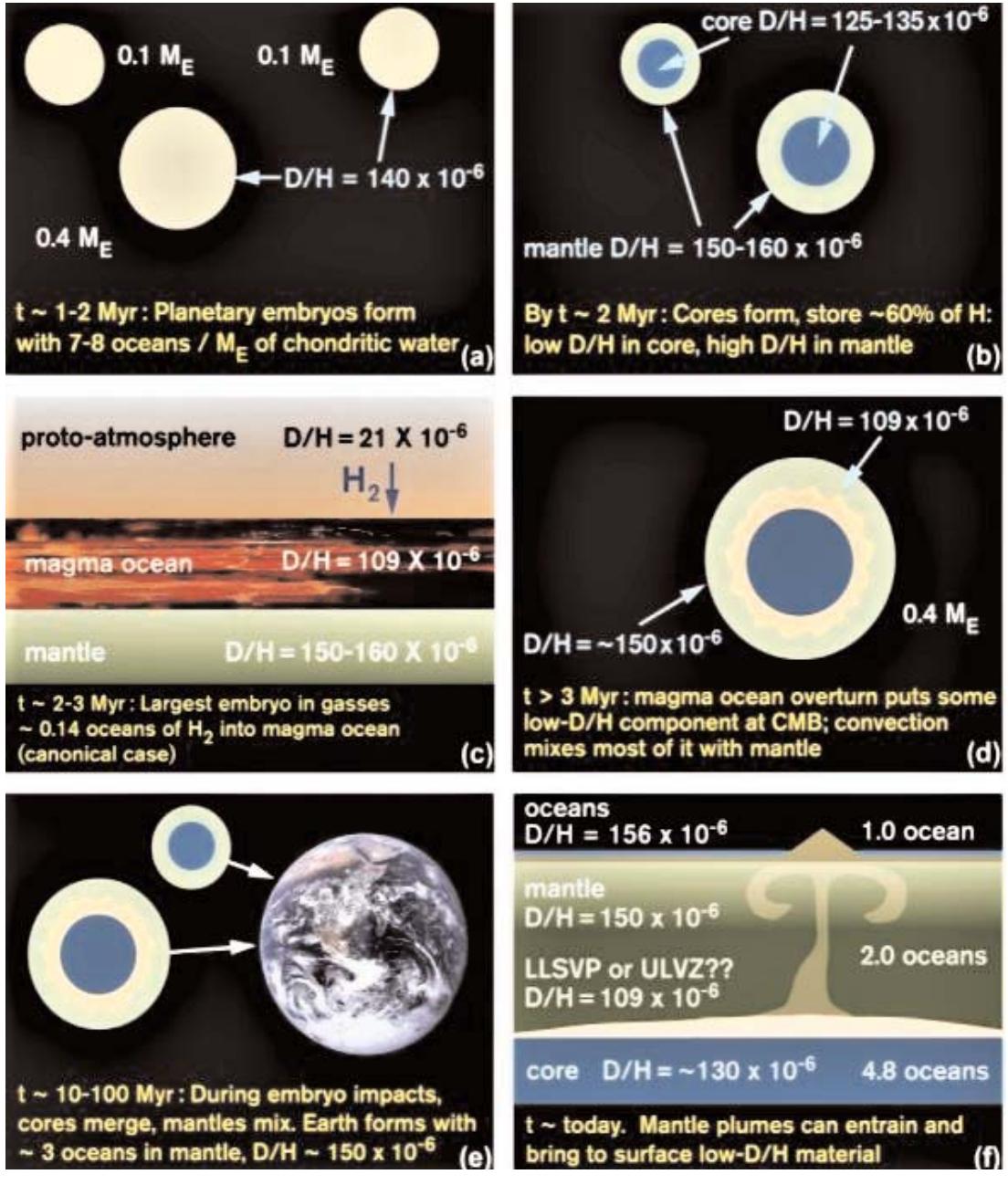
There are currently two classes of theories on the origin of ocean water and they are closely related to the cosmogony of the Solar System.

The first, the oldest, suggests that the water would come from the degassing of the Earth's mantle during the Hadean, more than 4 billion years ago. The volcanic gases, rich in water vapour, would then have cooled and formed the first clouds. The condensation of water would then have watered the Earth in the form of a primitive deluge which would have gradually formed and filled the oceans.

The other theory, more and more supported by the discoveries of scientists, is based on an extraterrestrial origin of water. Indeed, the Earth suffered during its formation an intense meteorite bombardment. Ice comets and asteroids similar to water-rich chondrite-type meteorites (dusts and micrometeorites may also have played an important role in the early history of the Solar System) are said to have brought the precious blue substance whose the Earth would have been sparsely provided. The influence of the gas present in the protoplanetary disc has also been proposed recently.

Deuterium, a key to the archives of the origin of the oceans

There are thus two types of water, one, ordinary, is made of hydrogen H atoms with a single proton for nucleus; the other, called heavy, is made of deuterium D atoms, so a nucleus with a proton and a neutron. First there is the formation of planetary embryos whose masses are between that of the Moon and that of Mars and whose collisions form a proto-Earth (a). These embryos are formed


0.1 M_E
0.1 M_E
D/H = 140 x 10^{-6}
0.4 M_E
t ~ 1-2 Myr : Planetary embryos form with 7-8 oceans / M_E of chondritic water
(a)
core D/H = 125-135 x 10^{-6}
mantle D/H = 150-160 x 10^{-6}
By t ~ 2 Myr : Cores form, store ~60% of H: low D/H in core, high D/H in mantle
(b)
proto-atmosphere
D/H = 21 X 10^{-6}
H_2
magma ocean
D/H = 109 X 10^{-6}
mantle
D/H = 150-160 X 10^{-6}
t ~ 2-3 Myr : Largest embryo in gasses ~ 0.14 oceans of H_2 into magma ocean (canonical case)
(c)
D/H = 109 x 10^{-6}
D/H = ~150 x 10^{-6}
0.4 M_E
t > 3 Myr : magma ocean overturn puts some low-D/H component at CMB; convection mixes most of it with mantle
(d)
t ~ 10-100 Myr : During embryo impacts, cores merge, mantles mix. Earth forms with ~ 3 oceans in mantle, D/H ~ 150 x 10^{-6}
(e)
oceans
D/H = 156 x 10^{-6}
1.0 ocean
mantle
D/H = 150 x 10^{-6}
LLSVP or ULVZ??
D/H = 109 x 10^{-6}
2.0 oceans
core D/H = ~130 x 10^{-6}
4.8 oceans
t ~ today. Mantle plumes can entrain and bring to surface low-D/H material
(f)

from chondritic material and, in the case of Earth, it is known to be mostly material similar to that found in enstatite chondrites. The D/H ratio of the bodies formed is therefore approximately 140 ppm.

Because of their higher content of radioactive elements than today and also because of the heat provided by accretion, these bodies partially melt and differentiate, giving a ferrous core and a mantle (b). But the laws of cosmochemistry tell us that deuterium will tend to stay in the mantle, while hydrogen concentrates in the nucleus so that the D/H ratio increases for the mantle and decreases for the nucleus.

The largest planetary embryos and of course the proto-Earth quickly surround themselves with an ocean of magma in which the gas still present in the protoplanetary disc will dissolve. The same process as before will then continue but the Earth, in particular its mantle, will see its content of hydrogen isotopes increase, which also increases its potential water sources (cd).

In total, approximately the equivalent of three oceans were in the mantle of the Earth which by volcanic degassing would therefore have led to the one we have today on its surface (ef). Between 10 and 30% of the water in this ocean comes indirectly from hydrogen isotopes absorbed by the oceans of magma.

This scenario was tested by cosmochemical signatures at the level of the abundances of carbon, nitrogen and rare gas and by measuring the D/H ratio in the rocks of the mantle which arrive at the surface of the Earth, due to convection in its mantle. and volcanism.

It is interesting in more ways than one because it suggests in particular that even exoplanets formed from materials poor in water could still contain significant quantities. They would have formed from the hydrogen that we know to be in all the protoplanetary discs.

For most of us, the cosmos is an organized unit. Liquid water, the source of life, is present everywhere in the Universe and finding water on a planet would make it possible to believe in an extraterrestrial life form.

Liquid water is undoubtedly omnipresent in the Galaxy, perhaps even more so than our Solar System suggests with planets like Mars, the object of all fantasies since the formulation of the hypothesis of life on Mars. On the other hand, if the presence of liquid water is a necessary condition for the appearance of life, it certainly does not appear to be a sufficient condition...

It should already be remembered that only liquid water has an interest: water ice or water vapor have no particular value for life. In fact, the interest of liquid water lies in its ability to promote chemical reactions.

Living beings are made up of an orderly arrangement of incredibly complex molecules: to create such edifices, simple organic molecules had to react chemically together, so as to grow and transform. It was therefore necessary to have a very specific environment allowing these reactions to take place.

Liquid water is one of the conditions favorable to life. In practice, only a liquid can fulfill this role, for two reasons:

The atoms inside a solid cannot practically move, which is the reason why a solid is rigid. This means that the molecules stay in their place and cannot meet: for lack of contact between various molecules, no chemical reaction can start;

The molecules of a gas are extremely dispersed. This is the reason why a gas is much lighter than a liquid (for example, water is a thousand times heavier than air); this is also why a gas is transparent, and why you can move around in it without difficulty. At the microscopic scale, this means that the molecules meet quite "rarely" compared to a liquid, since they are more scattered. Thus, the chem-

istry related to the reactions between molecules is possible in a gas, but it is much less efficient than in a liquid. Finally, only the liquid state can encourage the chemical reactions necessary for life.

Water is not the only one to have such properties: many other molecules are polar like it. Does extraterrestrial life really need liquid water to thrive? Couldn't she find another liquid with similar properties?

This would be to forget that water is one of the most common species in the Universe. To understand why, just note the abundance of different elements in the Universe: The abundance of helium and hydrogen is due to the fact that they are the only two elements created during the Big Bang. Oxygen, on the other hand, comes from the nuclear fusion that took place in the most massive stars, just like all the other elements.

Candidates for replacing water for life?
Of these three elements, helium is quite chemically inert. So there remains oxygen and hydrogen: hydrogen atoms can either bind together, forming H2 (the most abundant molecule in the Universe),

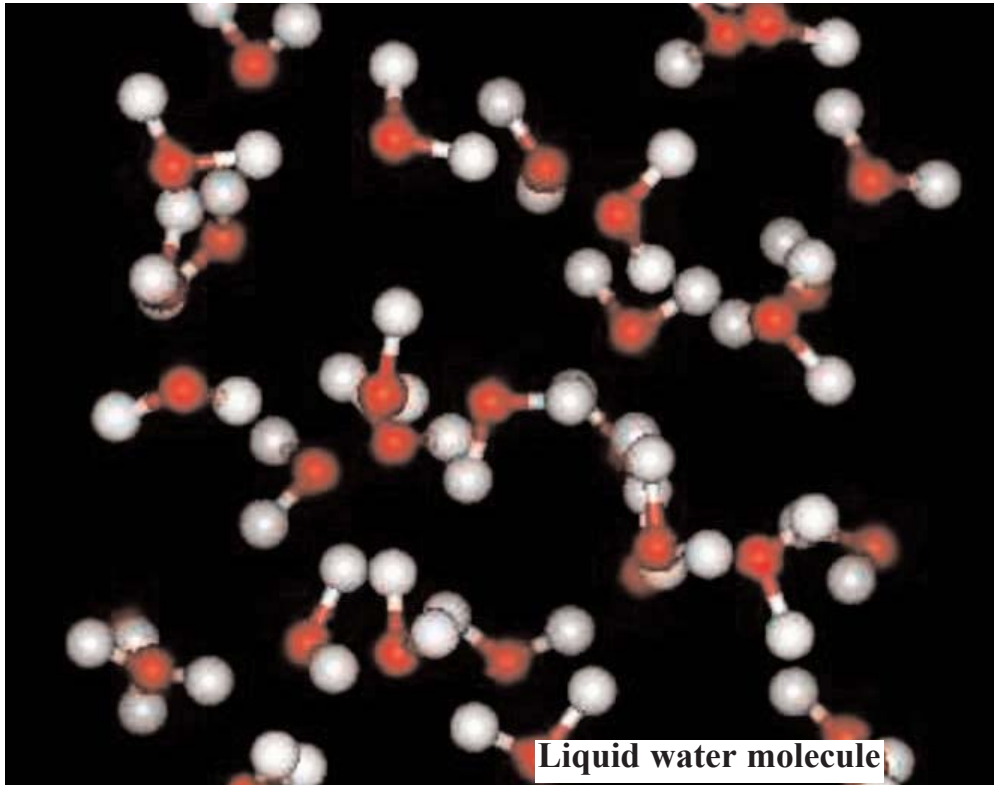
Hydrogène : 74%
Hélium : 24%
Oxygène : 1%
Tous les autres éléments réunis : 1%

or bind to oxygen, forming H2O. Besides dihydrogen, the water molecule is therefore the simplest molecule that can be formed from the most abundant elements in the Universe... Of all the polar molecules, water is by far the most common. .

Thus, water is the molecule of life par excellence. A look at the periodic table reinforces this conclusion: it helps to better understand the exceptional chemical properties of this molecule.
Finally, due to this exceptional property of the element oxygen, water H2O is the most polar molecule that can be formed among the simple species. Its exceptional "sticking" properties make it a fabulous reaction accelerator. Exceptional abundance, exceptional chemical properties... Water is essential for hypothetical extraterrestrial life! Where else in the galaxy could liquid water be found?

The first constraint is related to temperature and pressure conditions. The Solar System gives us valuable information about the possibilities of the existence of liquid water.

The planets of the solar system and water
The eight planets of the Solar System are very clearly subdivided into two categories: the four planets closest to the Sun are small and rocky (terrestrial planets), the four most distant planets are huge and mainly made up of gas (gas giants).



Liquid water molecule

However, this distinction is associated with another fundamental difference: most of the satellites of the gas giants are mainly made up of water ice, while the terrestrial planets are rather poor in water (including the Earth, where the oceans are deep only two kilometers while the rocky body is 6,380 kilometers in radius...). These two findings are interrelated:

far from the Sun, water is present in the form of ice. As it is a very abundant molecule, it added significantly to the mass of rocky bodies during the formation of the Solar System. Thanks to the weakness of solar radiation, these large rocky cores have retained the lightest gases such as helium and dihydrogen: as these two gases are by far the most abundant in the universe, these planets have grown disproportionately up to to become gaseous giants, surrounded by a procession of icy satellites; near the Sun, the intensity of the radiation tended to break up any water molecules in the vacuum of space, and so water did not add to the mass of rocky bodies. In addition, this radiation prevented light gases such as helium and dihydrogen from accumulating on the surface: the planets were only able to retain a thin atmosphere above rocky bodies poor in water.

The planets of the Solar System are therefore subdivided into two categories: those close to the Sun (dense and small, telluric planets), those far from the Sun (large and sparse, gas giants).

From a certain distance, the water ice was able to add to the mass of the rocky body: the combination of a large mass and low solar radiation made it possible to retain light gases such as dihydrogen or helium. This explains the large size and low density of the outer planets, which are mainly made up of gas.

This distinction raises a major problem: far from the Sun, water is omnipresent, but the solar radiation is too weak for it to pass into a liquid state. Near the Sun, the higher temperature allows the transition to the liquid state on bodies with a sufficient atmosphere, but water is very rare there.

Everything seems to contribute to making liquid water extremely rare...

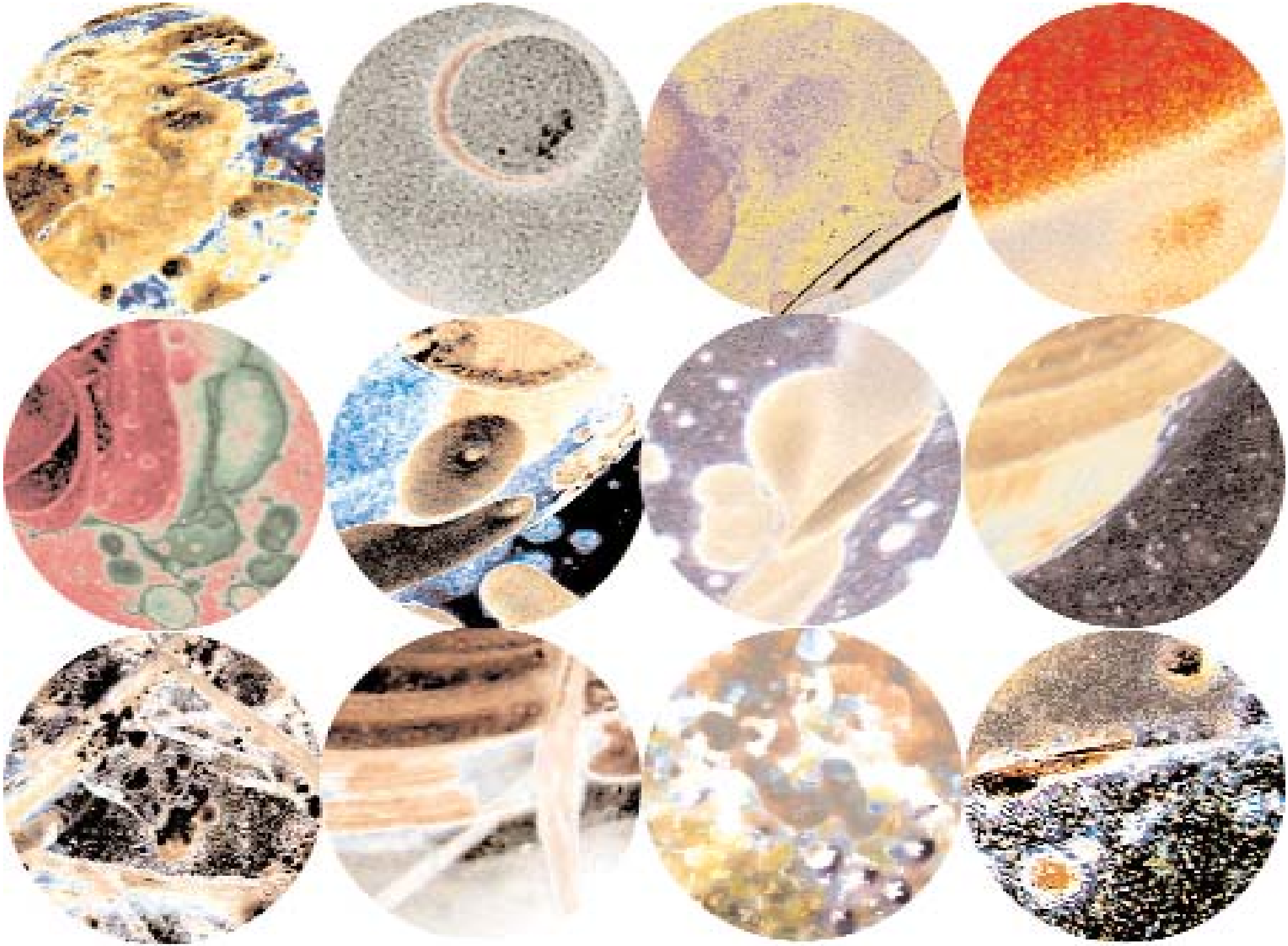
After studying the conditions of life, the characteristics of planets and water, here is a summary.
At first sight, the Earth seems to be exceptional in the sense that it is the only planet having liquid water on the surface in the current state of our knowledge. As this liquid water is intimately linked to life on Earth, this seems to make it an exceptional and extremely rare case.

In fact, liquid water may be far more common than the Solar System suggests. The water molecule is one of the most abundant in the Universe, and many mechanisms can allow it to pass into the liquid state.

The Solar System could even be rather poor in liquid water compared to other planetary systems: it contains only one terrestrial planet with liquid water, whereas there could have been two or three. And no gas giant satellite has liquid water on the surface in the Solar System, while this possibility cannot be ruled out on other planetary systems...

Liquid water would even be possible away from any star and any planetary system! Thus, a solitary gas giant with several large satellites influenced by tidal forces could allow water to pass in liquid form on one of these satellites...

Thus, the discoveries of water in the Solar System and elsewhere, made with great media fanfare, will logically continue in the future. On the other hand, one should not associate too quickly "water" and "liquid water" on the one hand, "liquid water" and "life" on the other hand. Liquid water is certainly not a sufficient condition for the development of life!



The conditions for extraterrestrial life

To consider the existence of extraterrestrial life, at least three conditions would have to be met in the same place:

1) presence of liquid water as a "reaction accelerator";
2) presence of an energy source to initiate these reactions;
3) presence of organic matter which can react.

For example, the planet-oceans we have talked about are undoubtedly very bad candidates for life: organic matter can only be found there at the bottom of the oceans, where solar radiation cannot reach.

Thus, no place there combines both the presence of organic matter and a sufficiently intense source of energy. Finally, the galaxy should probably be seen as a constellation of innumerable "oases" of liquid water, but many of which remain inanimate...

So much so that a third of exoplanets would be aquatic worlds. New research tells us a little more about the structure and characteristics of these mysterious planets larger than Earth, known as "planets-oceans", unknown in our solar system.

While the counter of exoplanets increases tirelessly - it displays 3,838 at the time of writing - the question that torments us all is: what can they look like? According to Harvard astronomer Li Zeng and his colleagues, many of them could well make our blue planet green with envy. Their analysis, presented at Goldschmidt's international conference on geochemistry in August and published in Monthly Notices of the Royal Astronomical Society, shows that worlds rich in water are commonplace: up to 35% of planets are made up of half of water! By comparison, all of Earth's oceans account for only 0.023% of its total mass.

"Realizing that there are so many planet-oceans was a huge surprise," Li Zeng said in a press release. It is an exciting discovery for the search for planets similar to ours and for extraterrestrial life. With a size generally between 2 and 4 Earth radii (RT) and a mass about 10 times greater than that of the Earth, these planet-oceans are at the upper limit of a category of exoplanets called super-Earths, planets between 1 and 10 Earth masses.

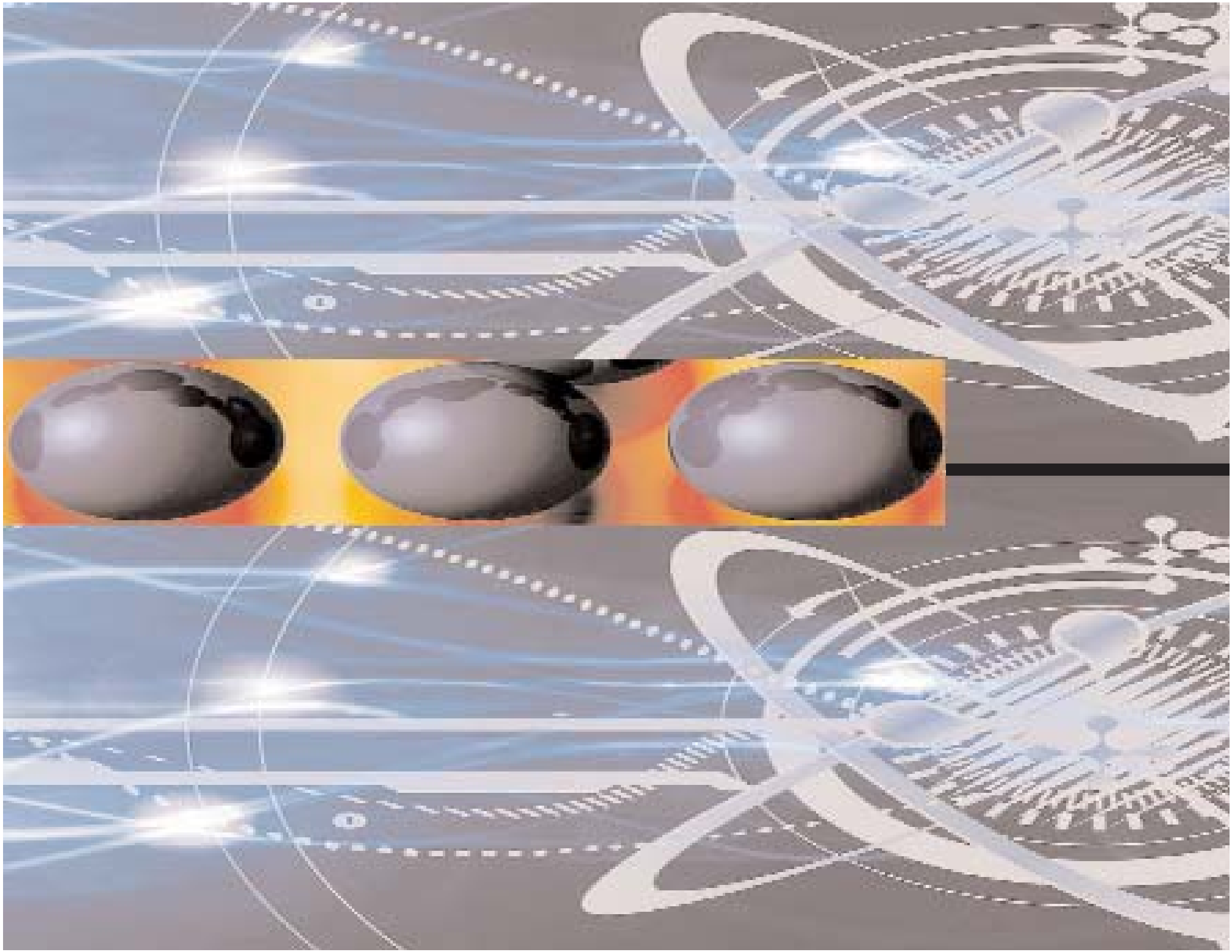
Water-rich super-earths

The researchers came to the conclusion that a third of known exoplanets were planet-oceans by developing a new model of their internal structure. This is based on Kepler's measurements for planetary radii, taking into account the major revisions made by the Gaia mission. The latter have recently pushed astronomers to revise downwards the number of exoterres , these planets of a size close to ours, discovered by Kepler. Information on the mass of exoplanets comes from terrestrial observatories.

What makes "the beauty of this model", according to Li Zeng, is that it explains the relationship between the mass, radius and composition of exoplanets. It indicates that small-sized planets, in this case those with a radius of less than 2 RT, are rocky and water-poor, while those of intermediate size (between 2 and 4 RT) are water-rich - these are planet-oceans. Those above 4 RT are rich in gas. Beyond 10 RT, we are also typically dealing with gas giants, mainly composed of hydrogen and helium.

The dimensions of the planets constrain their formation and their internal structure. Thus, during the early stages of their birth in the protoplanetary disk, "the planet-oceans certainly formed in a manner similar to the cores of the gas giants found in our solar system (Jupiter, Saturn, Uranus, Neptune)," says Li Zeng. "Failing to become gas giants", they would then have evolved differently to become water-rich super-Earths.

However, the term in French "planets-oceans", equivalent of the English "water worlds ", literally "worlds of water", is perhaps a little misleading. Because "it's water, but not the one commonly encountered on Earth", warns Li Zeng. "Their surface temperature

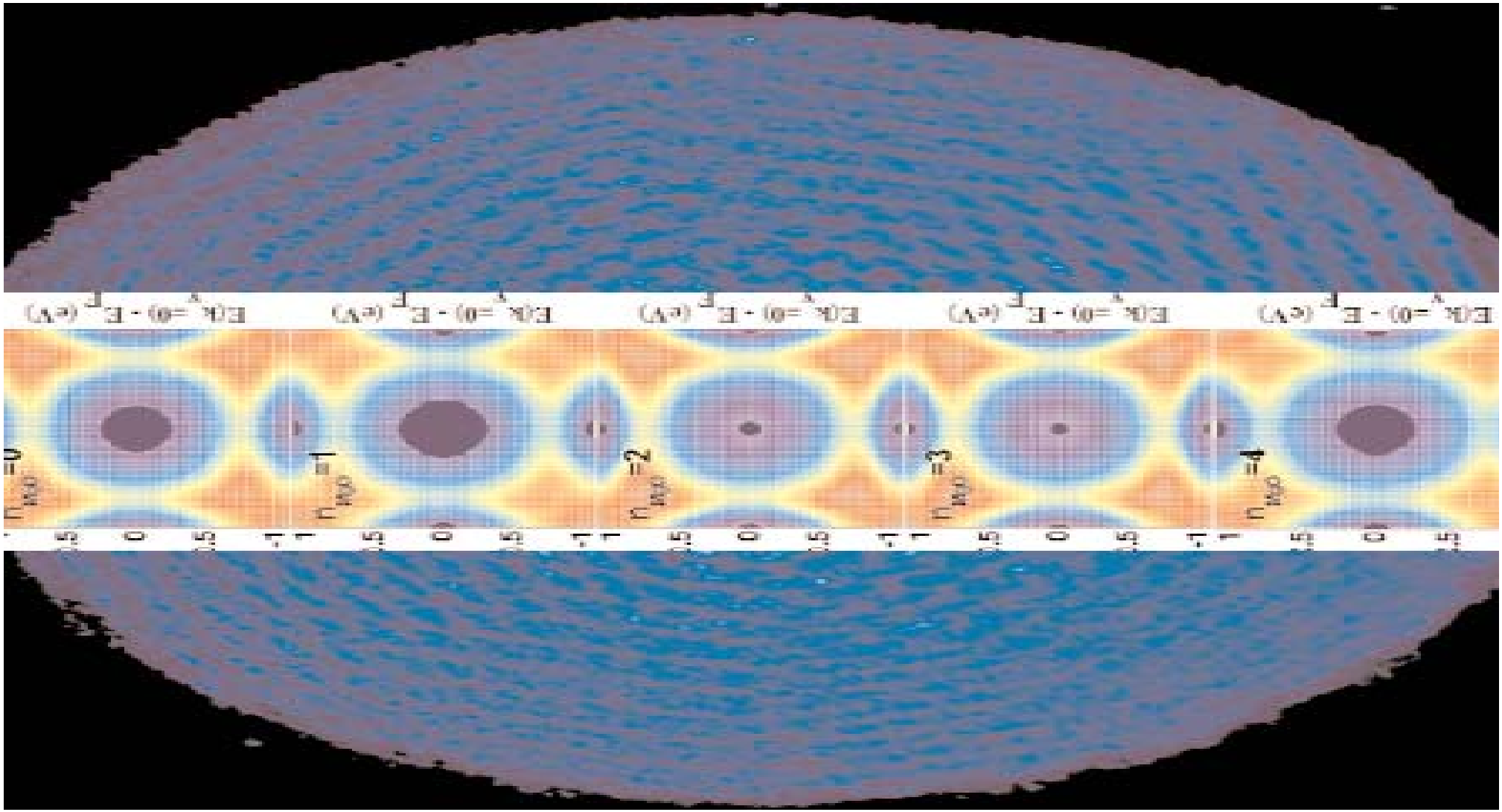


fluctuates between 200 and 500°C. Their surface could be enveloped in an atmosphere consisting mainly of water vapour, with a liquid layer below. Deeper down, this water turns into ice under high pressure. "Going even deeper into these planets, one would eventually reach the solid rocky core.

Thus described, the planet-oceans immediately appear much less hospitable. However, "life could develop in layers near the surface where the pressure, temperature and chemical composition are adequate", Li Zeng believes. This type of exoplanet could be "one of the most abundant in our Galaxy", he observes. He and his colleagues expect the Tess satellite, Kepler's successor, to reap a good harvest.

WHAT YOU MUST REMEMBER

35% of the approximately 4,000 exoplanets discovered to date would be worlds rich in water, commonly called planet-oceans. These planet-oceans are super-earths whose size oscillates between 2 and 4 times the radius of the Earth. They would contain up to 50% water, in the form of vapor in their atmosphere, of a liquid ocean below, then of ice in the bowels of the planet.



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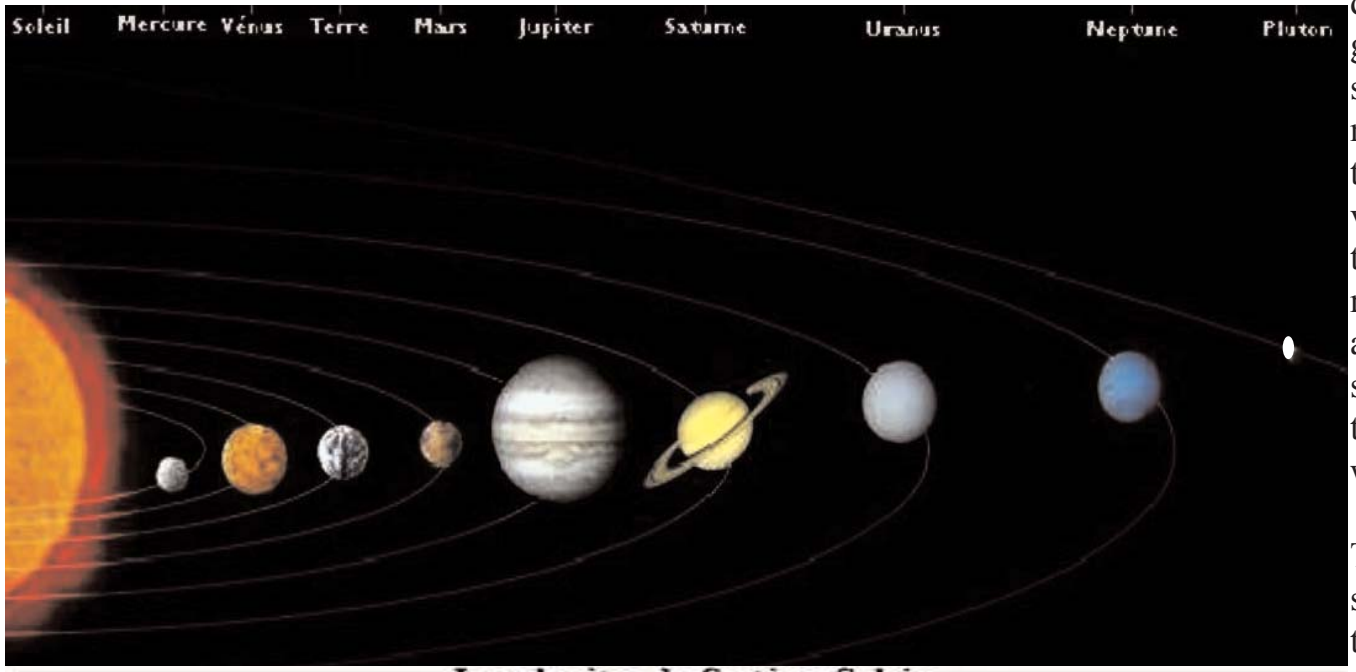


Les planètes du Système Solaire

Planète	*Distance au Soleil (Terre = 1)*	*Diamètre (Terre = 1)*	*Densité*
Mercure	0,39	0,38	5,4
Vênus	0,72	0,95	5,2
Terre	1	1	5,5
Mars	1,5	0,53	3,9
Jupiter	5,2	11,2	1,3
Saturne	9,5	9,4	0,7
Uranus	19,2	4,0	1,2
Neptune	30,1	3,9	1,6

the combination of a large mass and low solar radiation has made it possible to retain light gases such as dihydrogen or helium. This explains the large size and low density of the outer planets, which are mainly made up of gas.

This distinction raises a major problem: far from the Sun, water is omnipresent, but the solar radiation is too weak for it to pass into a liquid state. Near the Sun, the higher temperature allows the transition to the liquid state on bodies with a sufficient atmosphere, but water is very rare there.

Everything seems to contribute to making liquid water extremely

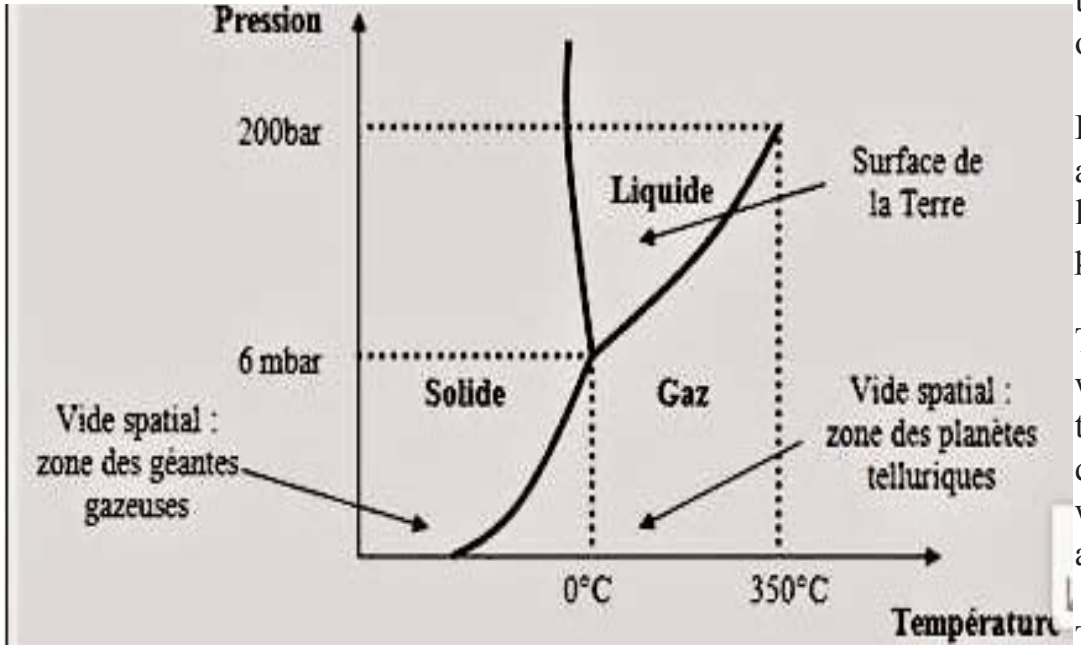


Diagramme de phase de l'eau : les états de l'eau sont représentés en fonction de la température et de la pression

rare...

After studying the conditions of life, the characteristics of planets and water, here is a summary.

At first sight, the Earth seems to be exceptional in the sense that it is the only planet having liquid water on the surface in the current state of our knowledge. As this liquid water is intimately linked to life on Earth, this seems to make it an exceptional and extremely rare case.

In fact, liquid water may be far more common than the Solar System suggests. The water molecule is one of the most abundant in the Universe, and many mechanisms can allow it to pass into the liquid state.

The Solar System could even be rather poor in liquid water compared to other planetary systems: it contains only one terrestrial planet with liquid water, whereas there could have been two or three. And no gas giant satellite has liquid water on the surface in the Solar System, while this possibility cannot be ruled out on other planetary systems...

Liquid water would even be possible away from any star and any planetary system! Thus, a solitary gas giant with several large satellites influenced by tidal forces could allow water to pass in liquid form on one of these satellites...

Thus, the discoveries of water in the Solar System and elsewhere, made with great media fanfare, will logically continue in the future. On the other hand, one should not associate too quickly "water" and "liquid water" on the one hand, "liquid water" and "life" on the other hand. Liquid water is certainly not a sufficient condition for the development of life!

The conditions for extraterrestrial life

To consider the existence of extraterrestrial life, at least three conditions would have to be met in the same place:

1) presence of liquid water as a "reaction accelerator";
2) presence of an energy source to initiate these reactions;
3) presence of organic matter which can react.

For example, the planet-oceans we have spoken about are undoubtedly very poor candidates for life: organic matter cannot

be there at the bottom of the oceans, where the sun's rays cannot reach. Thus, no place there combines both the presence of organic matter and a sufficiently intense source of energy. Finally, the galaxy should probably be seen as a constellation of innumerable "oases" of liquid water, but many of which remain inanimate...

So much so that a third of exoplanets would be aquatic worlds. New research tells us a little more about the structure and characteristics of these mysterious planets larger than Earth, known as "planets-oceans", unknown in our solar system.

While the counter of exoplanets increases tirelessly - it displays 3,838 at the time of writing - the question that torments us all is: what can they look like? According to Harvard astronomer Li Zeng and his colleagues, many of them could well make our blue planet green with envy. Their analysis, presented at Goldschmidt's international conference on geochemistry in August and published in Monthly Notices of the Royal Astronomical Society, shows that worlds rich in water are commonplace: up to 35% of planets are made up of half of water! By comparison, all of Earth's oceans account for only 0.023% of its total mass.

"Realizing that there are so many planet-oceans was a huge surprise," Li Zeng said in a press release. It is an exciting discovery for the search for planets similar to ours and for extraterrestrial life. Generally between 2 and 4 Earth radii (TR) in size and about 10 times the mass of Earth, these planet-oceans are at the upper limit of a category of exoplanets called super-Earths, planets between 1 and 10 Earth masses.

Water-rich super-earths

The researchers came to the conclusion that a third of known exoplanets were planet-oceans by developing a new model of their internal structure. This is based on Kepler's measurements for planetary radii, taking into account the major revisions made by the Gaia mission. The latter have recently pushed astronomers to revise downwards the number of exoterres , these planets of a size close to ours, discovered by Kepler. Information on the mass of exoplanets comes from terrestrial observatories.

What makes "the beauty of this model", according to Li Zeng, is that it explains the relationship between the mass, radius and composition of exoplanets. It indicates that small-sized planets, in this case those with a radius of less than 2 RT, are rocky and water-poor, while those of intermediate size (between 2 and 4 RT) are water-rich - these are planet-oceans. Those above 4 RT are rich in gas. Beyond 10 RT, we are also typically dealing with gas giants, mainly composed of hydrogen and helium.

The dimensions of the planets constrain their formation and their internal structure. Thus, during the early stages of their birth in the protoplanetary disk, "the planet-oceans certainly formed in a manner similar to the cores of the gas giants found in our solar system (Jupiter, Saturn, Uranus, Neptune)," says Li Zeng. "Failing to become gas giants", they would then have evolved differently to become water-rich super-Earths.

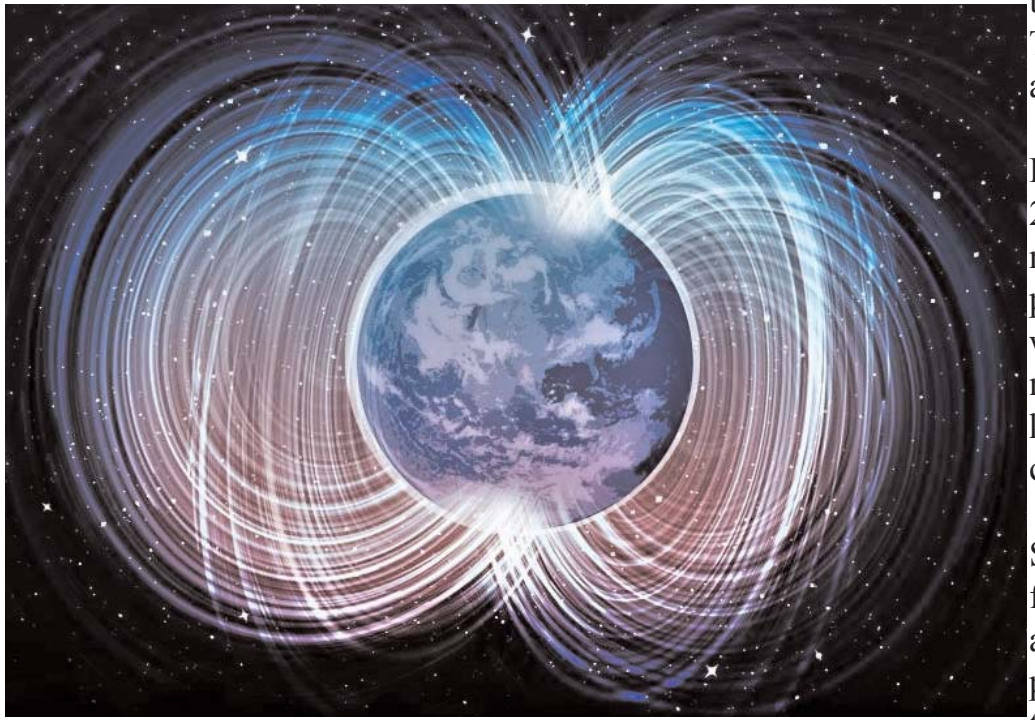
However, the term in French "planets-oceans", equivalent of the English "water worlds ", literally "worlds of water", is perhaps a little misleading. Because "it's water, but not the one commonly encountered on Earth", warns Li Zeng. "Their common temperature on Earth," warns Li Zeng. "Their surface temperature fluctuates between 200 and 500°C. Their surface could be enveloped in an atmosphere consisting mainly of water vapour, with a liquid layer below. Deeper down, this water turns into ice under high pressure. "Going even deeper into these planets, one would eventually reach the solid rocky core.

Thus described, the planet-oceans immediately appear much less hospitable. However, "life could develop in layers near the surface where the pressure, temperature and chemical composition are adequate", Li Zeng believes. This type of exoplanet could be "one of the most abundant in our Galaxy", he observes. He and his colleagues expect the Tess satellite, Kepler's successor, to reap a good harvest.

WHAT YOU MUST REMEMBER
35% of the approximately 4,000 exoplanets discovered to date would be worlds rich in water, commonly called planet-oceans. These planet-oceans are super-earths whose size oscillates between 2 and 4 times the radius of the Earth. They would contain up to 50% water, in the form of vapor in their atmosphere, of a liquid ocean below, then of ice in the bowels of the planet.

How was the Earth able to maintain its magnetic field for billions of years?

The forces that drive the outer core and generate Earth's precious magnetic field have been at work for billions of years. If convection appears to be the dominant mechanism, questions arise about its ability to have maintained the geodynamo effect over the very long term.



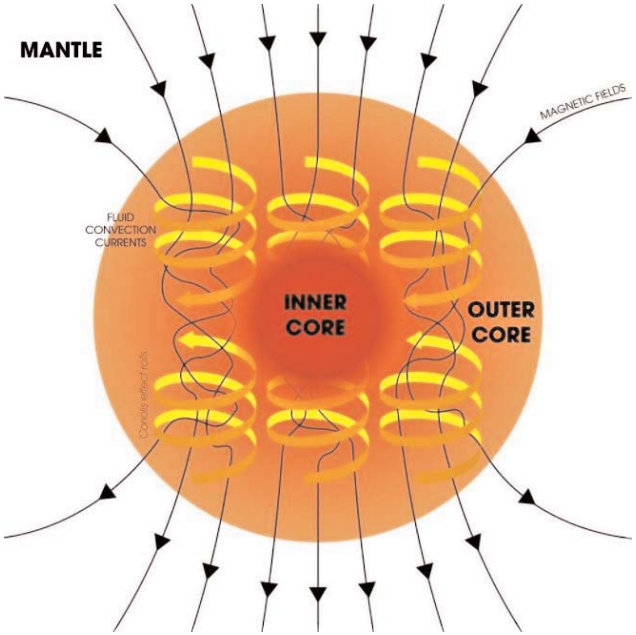
The magnetic field, which has protected the atmosphere as well as terrestrial life since its appearance, has its source in the heart of our Planet. More precisely, it is generated by the turbulent movements of the liquid iron that makes up the outer core. This geodynamo has been active for more than 3.4 billion years, and despite frequent and repeated inversions, it has never wavered. However, the mechanisms capable of sustaining these fluid movements over the very long term are still not fully understood. Several processes are mentioned, without their participation being clearly quantified.

The new core paradox

Natural convection is certainly the most accepted hypothesis today. Supported by numerical simulations, it appears that this mechanism, generated by the slow cooling of the Earth's core, is indeed capable of producing on its own a magnetic field which resembles that which is measured on the surface of the Earth. However, a question shakes the scientific community. This continuous convection over several billion years is intimately dependent on the thermal conductivity of the core, the value of which is currently highly debated. Thermal conductivity represents the ability of rocks to conduct heat and evacuate it outside the Earth.

However, the published data range over a very wide range, between 20 and 250 Wm-1.K-1. If the lowest values question the maintenance over time of an efficient convective system, the highest also pose a problem, by suggesting that the majority of the heat flux would then escape too quickly to produce a convection capable of maintaining in a strong magnetic field over time. This problem, known as the "new core paradox", perhaps highlights the fact that convection is not the only mechanism at work.

Scientists have therefore focused on the analysis of the various possible solutions and their respective contribution to the geodynamo effect.



Journey to the Center of the Earth: The Mantle

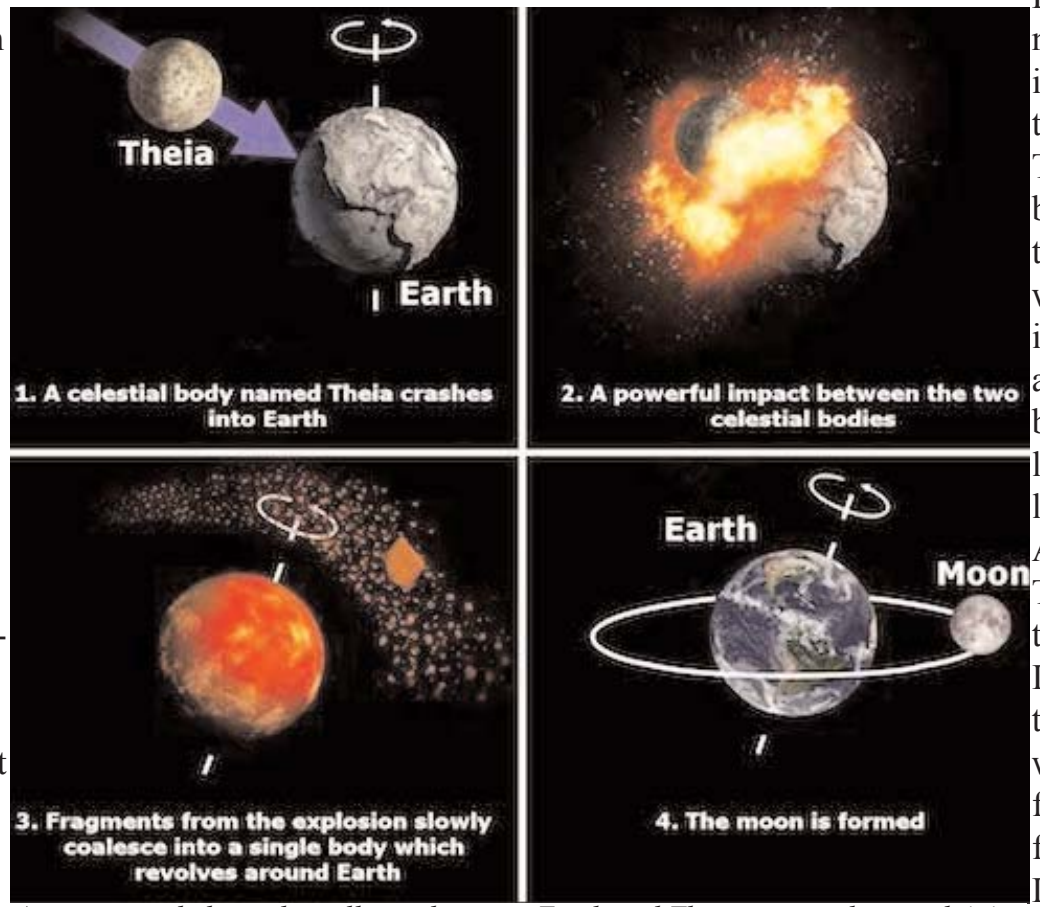
Every day the 'weather' is the same: mild 1827C (3321F), with some areas of high pressure - equivalent to about 1.3 million times the amount on Earth's surface. In this crushing environment, atoms warp and even the most familiar materials begin to behave eccentrically - rock is flexible like plastic, while oxygen acts like metal. But this breathtaking wonderland is not an alien planet. It is, in fact, the Earth itself - just very, very deep underground.

In particular, the framework in question is the lower mantle - the layer of rock that sits just above the center of the Earth, the core. This mostly solid mass is another world, a swirling, strewn place with a kaleidoscope of crystals, from diamonds - there are about a quadrillion tons of them in the mantle in total - to minerals so elusive they don't exist. on the surface.

The collision with Theia, the ghost planet

It's a little known fact that there are actually three celestial bodies in our small part of the solar system - the Earth, the Moon and Theia. Today, the latter is nothing more than a ghost, having crashed into our planet 4.5 billion years ago. For decades, it was thought that when this tiny Mars-sized planet collided with fledgling Earth, the resulting debris - mostly from the other planet itself - coalesced to form the Moon.

After crashing into primeval Earth, Theia (named after the mythical Greek Titan who was the mother of Selene, the Moon Goddess) mixed with its interior contents, becoming part of the mantle.


Theia
Earth
1. A celestial body named Theia crashes into Earth
2. A powerful impact between the two celestial bodies
3. Fragments from the explosion slowly coalesce into a single body which revolves around Earth
Earth
Moon
4. The moon is formed

Astronomers believe the collision between Earth and Theia occurred around 4.4 to 4.45 bya; about 0.1 billion years after the Solar System began to form. In astronomical terms, the impact would have been of moderate speed. It is believed that Theia struck the Earth at an oblique angle when the Earth was almost completely formed. Computer simulations of this "late impact" scenario suggest an initial impactor velocity at infinity of less than 4 kilometers per second (2.5 mi/s), increasing as it fell to more than 9 .3 km/s (5.8 mph) at impact, and an impact angle of approximately 45°.

During this time, the Moon did not form from the alien planet itself, but from shards of earth that were destroyed.
The twist is that Theia didn't blend into the Earth in its entirety. Most of it was so dense that it was unaffected by currents inside the mantle - in fact, the alien planet still exists today as bits inside the earth, probably located in two continent-sized layers of rock beneath West Africa and the Pacific Ocean. They are the biggest extraterrestrial thing in the Earth's mantle. It's possible it's the LLSVPs, and there are fragments of an alien world lurking deep beneath our feet. restre qui se cachent profondément sous nos pieds.
LLSVP: Large Low Shear Velocity Province where seismic waves encounter resistance and slow down.)

The oldest idea is that drops with a different chemical composition than the surrounding rock -

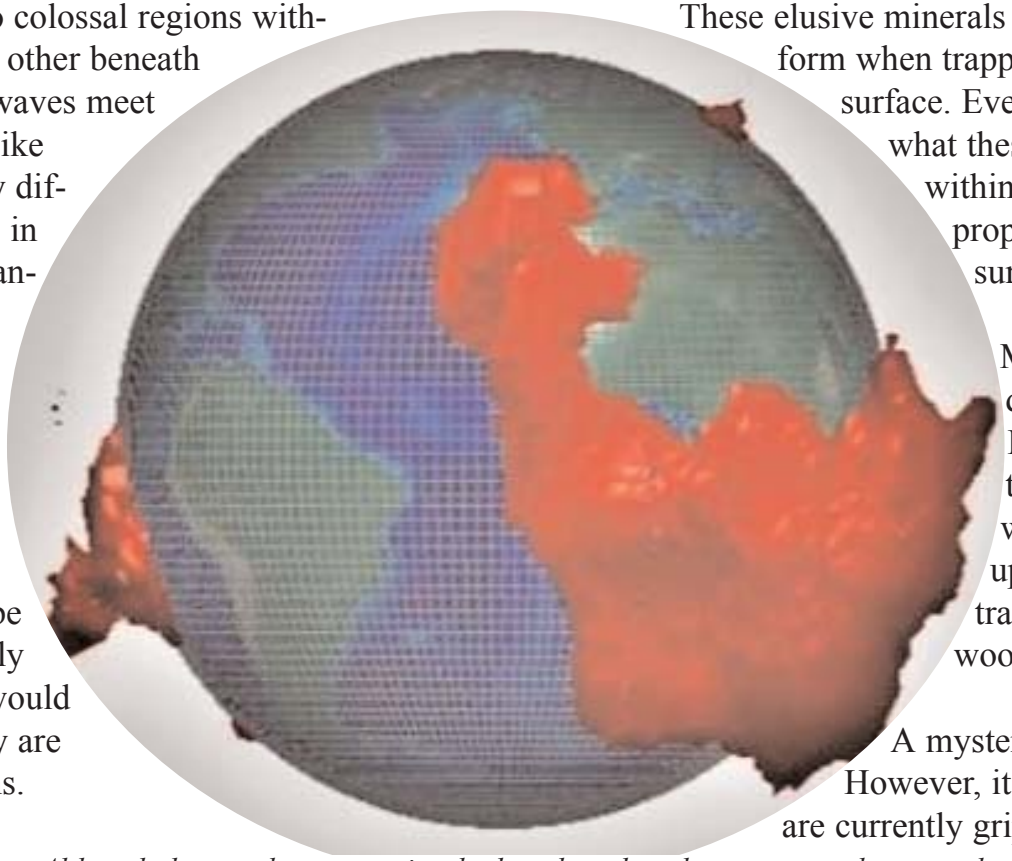
maybe they are made up of minerals that are unusually rich in something heavy, like iron or nickel and are really old, dating back billions of years to primordial Earth, when our planet was still forming and its mantle - which is now made of solid rock - was an ocean of molten magma. As the minerals in this layer began to harden and crystallize, some areas retained impurities that had been mixed in while it was still liquid. These remained in place all this time and now form the odd LLSVPS. The age of the LLSVPs in question also matches Theia's collision theory.

Although the mantle was previously believed to be a homogeneous layer, geologists have detected two colossal regions within it, one straddling Africa and the other beneath the Pacific Ocean, where seismic waves meet resistance. and slow down. Much like Earth's core, these areas are clearly different from the rest of the mantle - in fact, they represent some of the planet's greatest features. Together, these areas contain about six times the mass of the moon.

These are the large low shear rate provinces, or LLSVPs. It is difficult to find a familiar analogue for their peculiar shapes - they could be described as mountains or unusually bulbous mounds, although Lekic would not use these words himself. "They are bigger than continents," he explains.

Curiously, the structures appear to bear a closer resemblance to colossal piles of sand - a study found they had steep slopes in places, as well as shallow slopes and even a few overhangs. Amid the debate over their appearance, the features are known as blobs. But the confusing appearance of LLSVPS is nothing compared to the confusion surrounding their formation - or even what they are made of.

Indeed, the most abundant rocks in this layer, bridgmanite and davemaoite, are largely mysterious to scientists. They need the unique ultra-high pressures inside the planet to grow and break apart if brought to our own realm - the geological equivalents of deep-sea alien fish that melt when trawled from the bottom of the sea.



Although the mantle was previously thought to be a homogeneous layer, geologists have detected two colossal regions (in red) within it, one straddling Africa and the other beneath the Pacific Ocean, where waves earthquakes encounter resistance and slow down. Much like Earth's core, these areas are clearly different from the rest of the mantle - in fact, they represent some of the planet's greatest features.

These elusive minerals can only be seen in their natural form when trapped inside diamonds brought to the surface. Even then, it is impossible to predict what these crystals would look like deep within the Earth, because their physical properties are so altered by the pressures under which they usually exist.

Meanwhile, the distant "ocean" does not contain a drop of liquid. Instead, it's made from water trapped in the mineral olivine, which makes up over 50% of the upper mantle. At deeper levels it transforms into indigo blue ringwoodite crystals.

A mystery of the depths

However, it is the "waters" of deep Earth that are currently gripping geologists around the world. At these depths, the chemistry changes completely, there are minerals that would become more transparent.

Ocean Ringwoodite

Coming from a volcanic rock brought up by chance to the surface of the land in Mato Grosso, Brazil, a mineral called ringwoodite was mined from a small brown diamond by Graham Pearson's team from the University of Alberta in Canada. Previously ringwoodite had already been discovered in meteorites. This is the first time that a scientist has found this mineral that contains water in a sample of terrestrial origin, usually located at a depth inaccessible because this rock crystal can only form at more than 500 km deep. And it was by a happy coincidence that Pearson was able to analyze it before the ringwoodite returned to its usual form at low pressure.

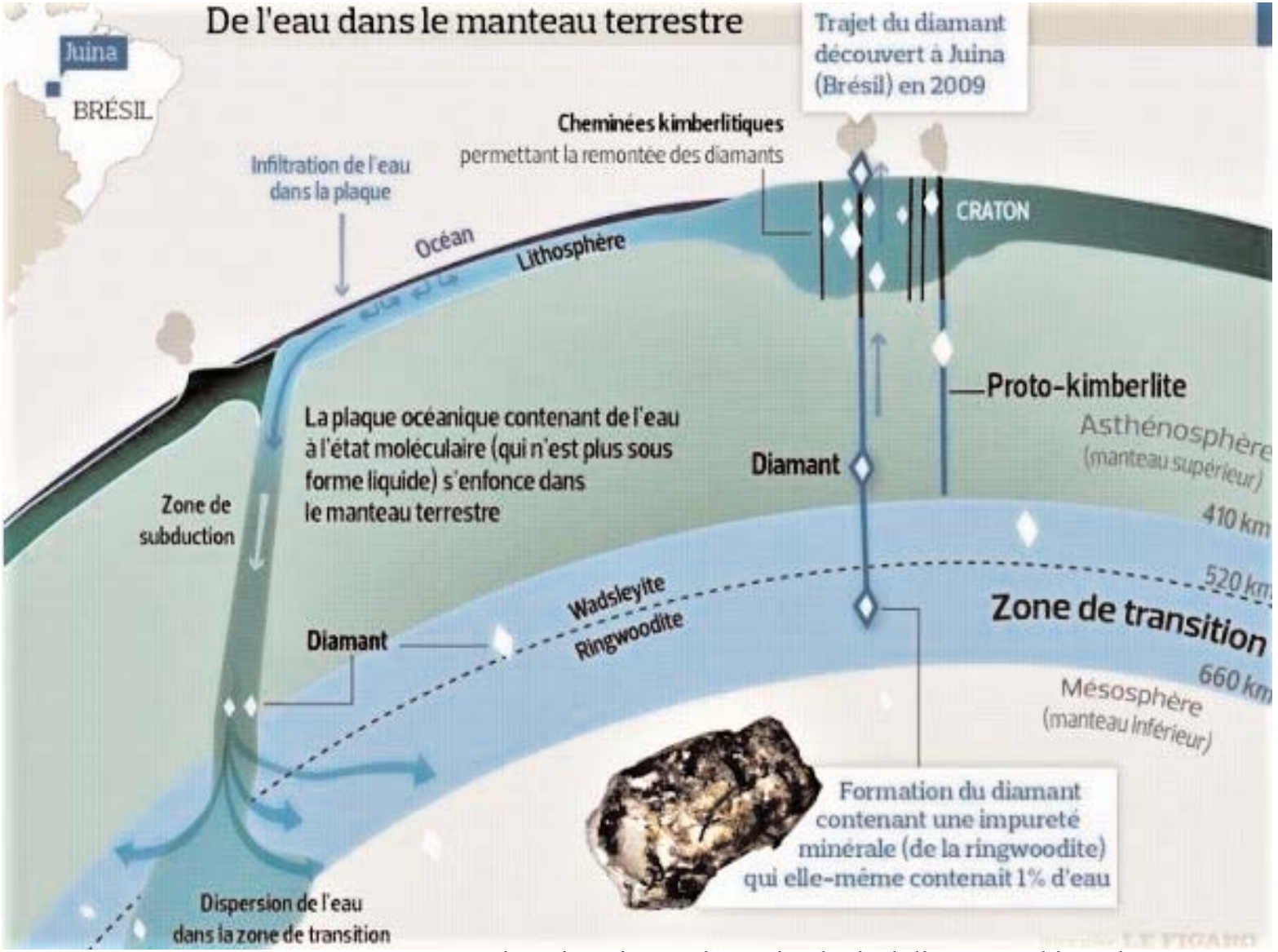
Obviously, this water could not appear by magic and, in analyzing the stone, Pearson came to the conclusion that there was water buried far below the surface of the earth - a lot of water and this discovery confirmed the theory according to which a water reserve, located between 410 and 660 kilometers deep underground, "could contain as much water as all the oceans reunited". Indeed, it has been forty years since a famous geologist Australian, Ted Ringwood, theorized the existence of a layer of transition in the Earth's mantle located between 400 and 600 km depth. The earth's crust, including the bottom of the oceans, reaches depths of about 100 kilometers. Below, we finds the upper mantle, which extends for 300 kilometers. And it was in the transition zone between the upper mantle and the lower mantle, between 410 and 660 kilometers below the Earth's surface, that the piece of ringwoodite that the researchers found was formed.

"The first hypothesis is that the water in ringwoodite is inherited from an aqueous diamond-forming fluid, from which the water arose during a syngenetic phase. In this model, the aqueous fluid would come from of the transition zone, as there is no evidence that the lower mantle contains any significant amount of water," writes Pearson. Basically, the extreme pressure and the chemical composition of the materials at such depths cause water to appear spontaneously.

"The other hypothesis is that ringwoodite is 'protogenetic', that is, it was present before it was encased in stone and its composition mirrors that of the transition zone," Pearson writes. In this model, water and ringwoodite are already present, and the ringwoodite absorbs some of the water. Anyway, there is a lot of water in the transition zone: "Both models imply that the transition zone is water-rich, at least in places," he wrote.

Hans Keppler, from the University of Bayreuth in Germany in Further analysis of Pearson's discovery confirms predictions from laboratory experiments that a reservoir of water equivalent to all of the oceans is hiding deep in the Earth's mantle. According to Keppler, scientists have long believed that the Earth harbors reservoirs of water far below its surface. But they weren't sure if water could be found that deep in the transition zone, between the upper and lower mantle. Everything has changed since this discovery. By reconstructing in the laboratory the extreme temperatures and pressures that prevail at these depths, researchers succeeded in transforming the olivine into a new crystal, which they named "ringwoodite", in homage to their Australian colleague.

This area must have been very rich in an unprecedented crystalline form of olivine… and in water. Between 410 and 520 km, the olivine must actually exist in a still slightly different crystalline form called wadsleyite. In theory, this crystalline variant has the same hydration capabilities as ringwoodite. If the entire layer located between 400 and 600 km contains well 60% of this crystal, as the theory predicts, then there would be as much water in this layer than in all the oceans combined. "This water is present in a form a little different from what we know", specifies the scientist Nathalie Bolfan-Casanova. "These are groups hydroxyls (oxygen-hydrogen or OH) that are trapped in the crystal. But if ringwoodite is heated at ambient pressure, it gives good olivine and water."


De l'eau dans le manteau terrestre
Juina
BRÉSIL
Trajet du diamant découvert à Juina (Brésil) en 2009
Cheminées kimberlitiques
permettant la remontée des diamants
Infiltration de l'eau dans la plaque
Océan
Lithosphère
CRATON
Proto-kimberlite
La plaque océanique contenant de l'eau à l'état moléculaire (qui n'est plus sous forme liquide) s'enfonce dans le manteau terrestre
Diamant
Asthénosphère (manteau supérieur)
410 km
Zone de subduction
520 km
Wadsleyite
Ringwoodite
Zone de transition
Diamant
660 km
Mésosphère (manteau inférieur)
Formation du diamant contenant une impureté minérale (de la ringwoodite) qui elle-même contenait 1% d'eau
Dispersion de l'eau dans la zone de transition

But then how does a piece of ringwoodite from 700 miles below the earth's surface ends up in a river Brazilian? According to Keppler - and if we are to believe the fact that Pearson was initially looking for volcanic rocks - chances are that something, probably a volcanic eruption, caused it rapidly pushed to the surface.

Unless there is a major technological discovery, this tank gigantic will forever remain inaccessible. No matter the means implemented, man has never managed to drill more than 12 km below the Earth's surface.

Either way, there's a growing consensus that Earth's strange drops, as far away as they seem, are affecting life on the surface in tangible ways.

For starters, they can influence the distribution of volcanoes. Many of the world's most famous geological hotspots, such as the Ring of Fire, a 25,000 mile (40,233 km) long chain of volcanoes encircling the Pacific Ocean, lie above where tectonic plates meet and jostle for space. But curiously, some very active areas do not follow this pattern. The Hawaiian Islands in the North Pacific Ocean are home to six active volcanoes, as well as vast lava fields and some places where magma boils almost continuously. This is despite the fact that they sit safely in the middle of the Pacific plate, thousands of miles from everyone else. It seems that LLSVPS encourage them to grow in particular places. If so, it suggests that these particular hidden structures have a profound impact on our planet - effectively dictating where certain groupings of volcanoes occur, as well as the island chains they create. The Hawaiian archipelago wouldn't exist without them - and neither would the Chinese island of Hainan.

The Ring of Fire takes the form of a ring, hence its name, and brings together a tangle of borders between the Pacific plate and its neighbors. As we can see on the map above, its main component plates are: Sandwich Plate, Scotia, South American, Nazca, Cocos, Caribbean, North American, Juan de Fuca, Eurasian, Filipino, Australian. Of course, these are only the most important plates and organized schematically, they are by no means the only constituent plates of the belt.

There is also a whole range of small lithospheric plates, with very small sizes, in the geological recesses of the Ring of Fire. However, the major plates of the Ring of Fire are enough to explain the volcanic activity that reigns on the belt, as on the map above where only the most important points appear.

The volcanism of "hot spots".
Locally, the rise of heat and molten material from very great depths leads to the construction of voluminous volcanoes. The deep sources of magmas being independent of the plates of the earth's crust and their movements, this volcanism occurs both in the oceanic and continental domains. The Hawaiian Islands, Reunion, the Galapagos Islands, Etna, the Massif Central, the Hoggar in Algeria, or even Etna in Sicily are active or extinct hotspots.

Volcanism associated with subduction zones or active margins which represent areas where two plates collide.

When the two plates are continental, it gives rise to an island arc. In the most frequent pattern, the confrontation of an oceanic plate and a continental plate, it results in the formation of a continental volcanic arc, parallel to the coast (case of the volcanoes of the Andes Cordillera). This volcanism is caused by the plunge of the oceanic crust into the mantle, under the zone of confrontation of the two

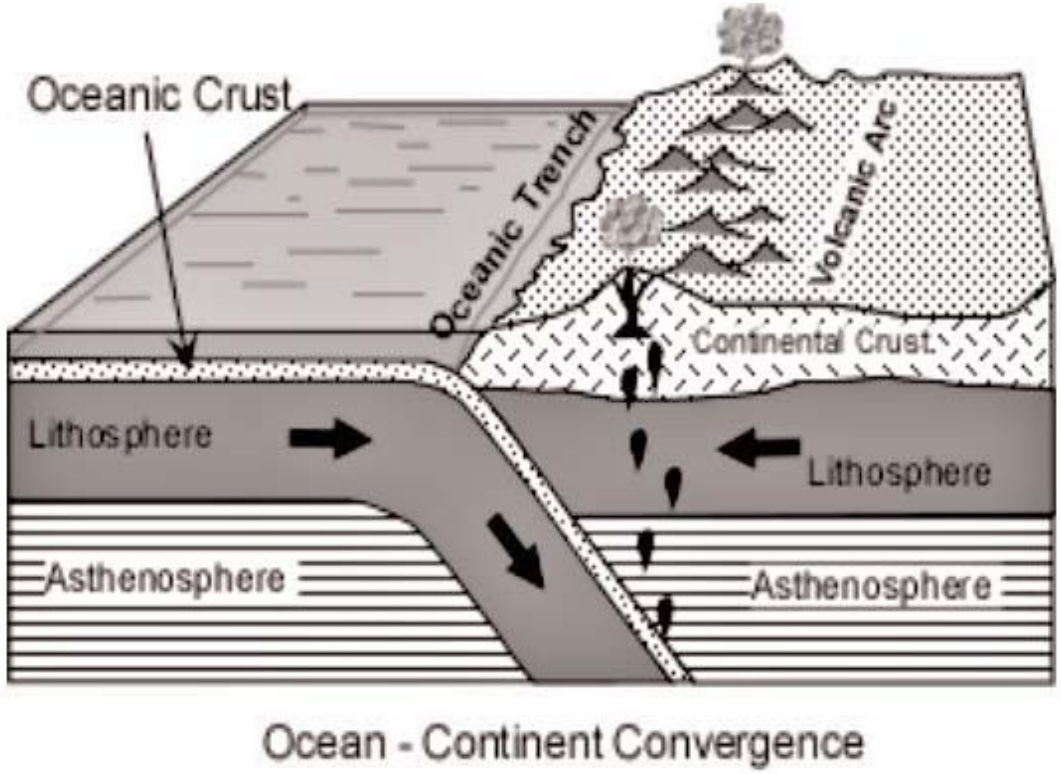
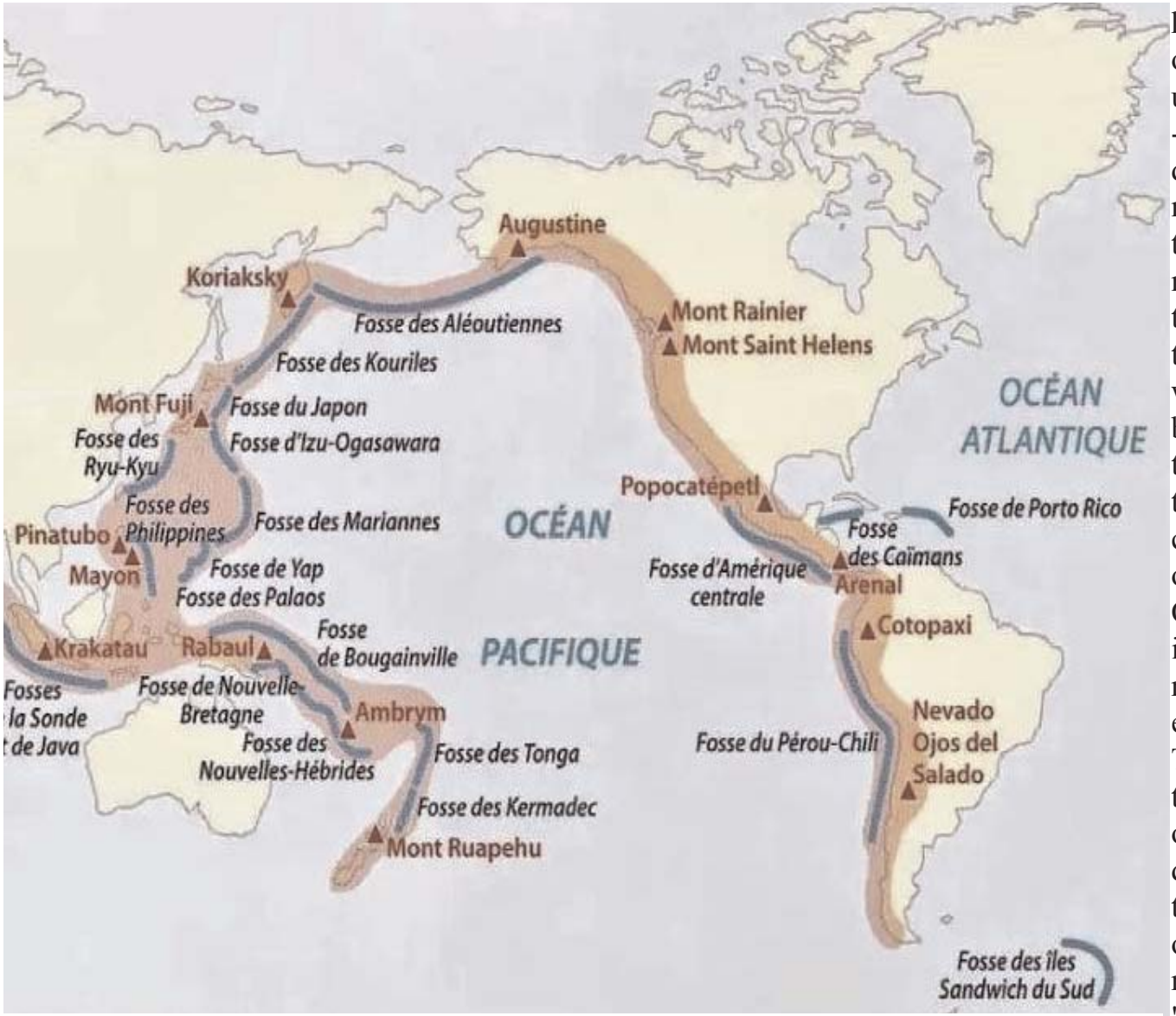


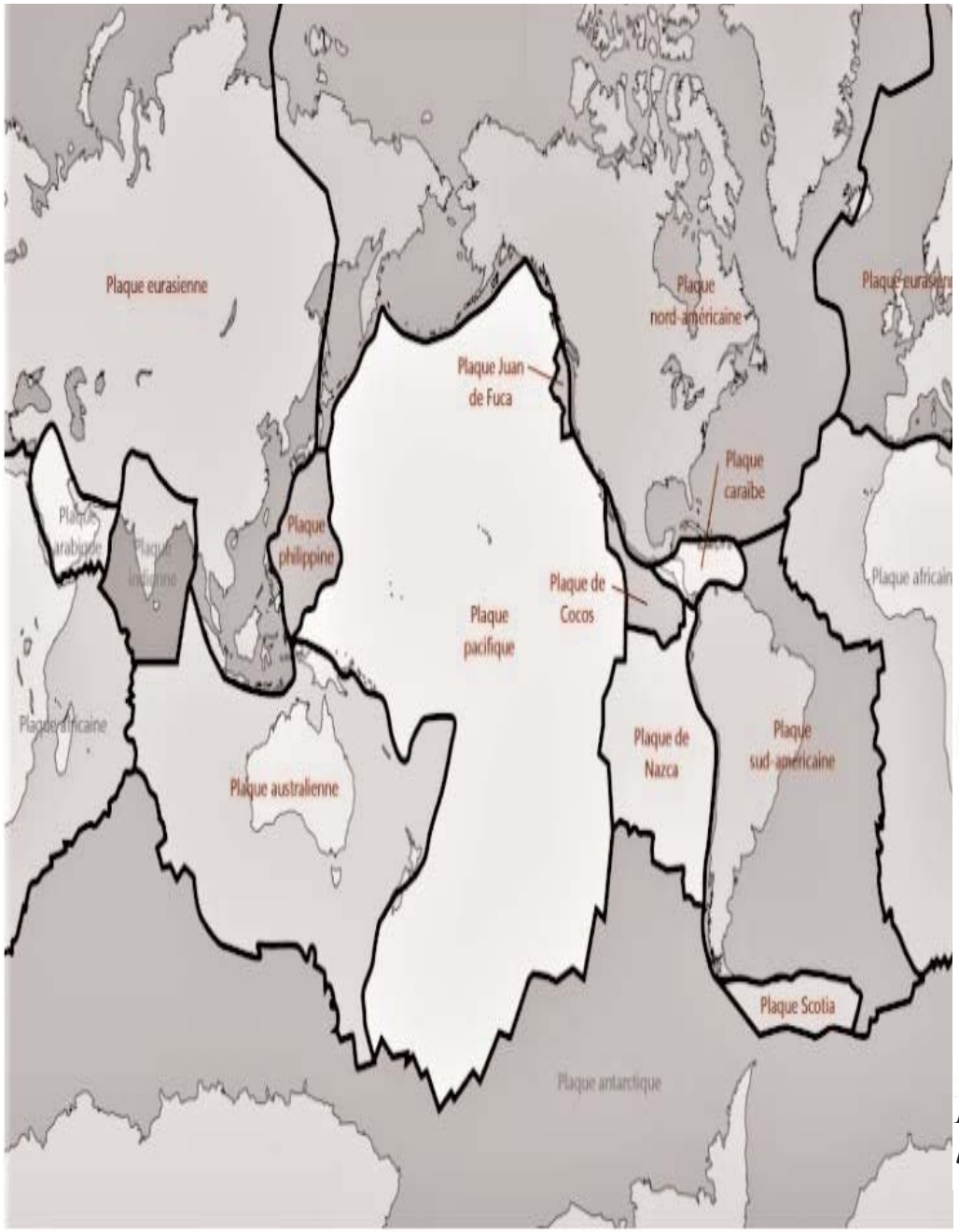
Diagram representing the origin of volcanism on the subduction zones between the oceanic plate (on the left) and the continental plate (on the right). The whole ring of fire is organized in this way.

plates.

This burial causes the progressive heating of this crust as it progresses in the mantle under the continent. The fluids released by the dehydration, then the melting of this subducted oceanic crust mix with the upper mantle, causing the partial melting of the rocks that constitute it, thus giving rise to so-called primary magmas. During their ascent, the latter evolve to generate the range of volcanic rocks observed on the surface. The continental crust, mainly composed of granite, was formed at the beginning of the Earth's history and its volume has remained globally stable since. In contrast, oceanic crust is continuously being created at ocean ridges and disappearing in subduction zones. The "classical" vision, known as Penrose, of the structure of the oceanic crust, is based on the model of a column comprising from bottom to top: gabbros - vein complex - basalts. The Penrose model describes the oceanic crust as an assembly of magmatic rocks comprising, from the base to the summit: gabbros (crystallization of magmas at depth) -- a vein complex created by the injection of lava --, pillow basalts (crystallization of magmas on contact with sea water). The whole is about 7 km thick. The base of the gabbros marks the transition with the peridotites (mantle rocks) and represents the interface called "Moho". This lithological column was validated during drilling in the oceanic crust, particularly in the Atlantic Ocean, as well as by direct observations during dives carried out on board the exploration submarine Nautile, on fracture zones exposing a lithological section of the crust. This type of so-called "Penrose" crust has therefore become the typical reference for an oceanic crust. . Through sonar images and drilling, scientists have revealed the existence of large dome-shaped structures on the ocean floor, mostly composed of mantle rocks. These structures have been named "core ocean complexes" or "megamullion".



Map showing the Ring of Fire (pink area), its main volcanoes (red triangles) and the pits in blue.



Carte des principales plaques lithosphériques à la surface de la Terre. Les plaques en rouge sont les plaques en lien avec la ceinture de feu.

Map of the major lithospheric plates on the Earth's surface. The plates in red are the plates related to the ring of fire.

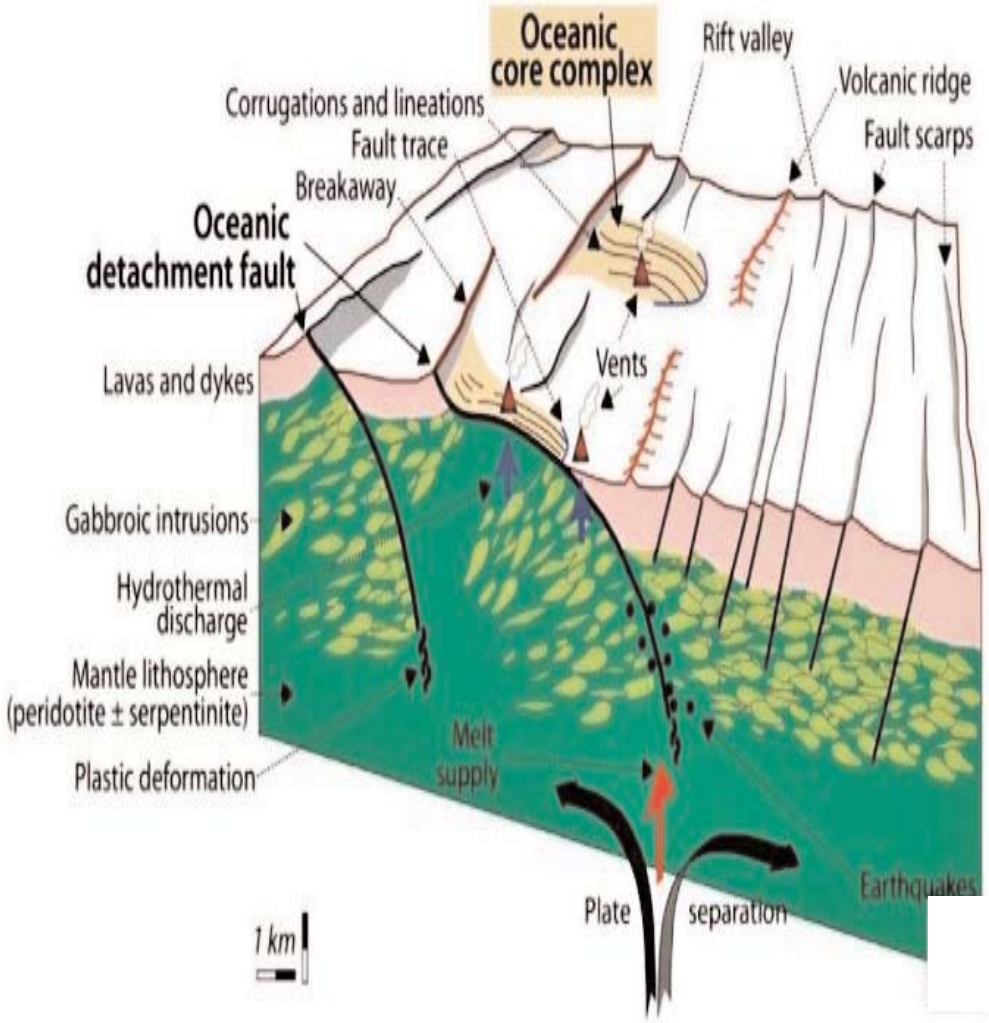


Diagram showing the formation of complex oceanic cores, at the level of a slow ridge, through a detachment fault.

Exsolution, tides and precession: a significant participation ?

Among the mechanisms considered, there is the exsolution of light elements. This process describes the escape of certain light chemical elements from the core, which leads to a gradual densification of the metallic liquid. The terrestrial tides generated by the gravitational attraction of the Moon as well as the precession of the Earth, are also alternative mechanisms to be considered. Precession represents the slow variation of the rotational orientation of the Earth. It appears that these last two orbital factors would indeed be capable of producing turbulent flows within the outer core, and therefore of participating in the geodynamo effect. It remains to be seen whether this participation is significant or not.

In a study published in the journal Nature Reviews Earth and Environment, researchers from the Institut de Physique du Globe de Paris and ISTerre, in Grenoble, take stock of the role played by these different mechanisms in the generation, on the long term, the earth's magnetic field.

Convection, yes, but with the help of exsolution
It thus appears that the Earth's precession is a minor parameter, the flow it produces within the outer core being far too weak to participate significantly in the geodynamo effect. The tides, on the other hand, may well play an important role. The results suggest that they may have been a major mechanism during Earth's earliest times, more than 1.5 billion years ago, when Earth's tidal forces were much stronger than today.

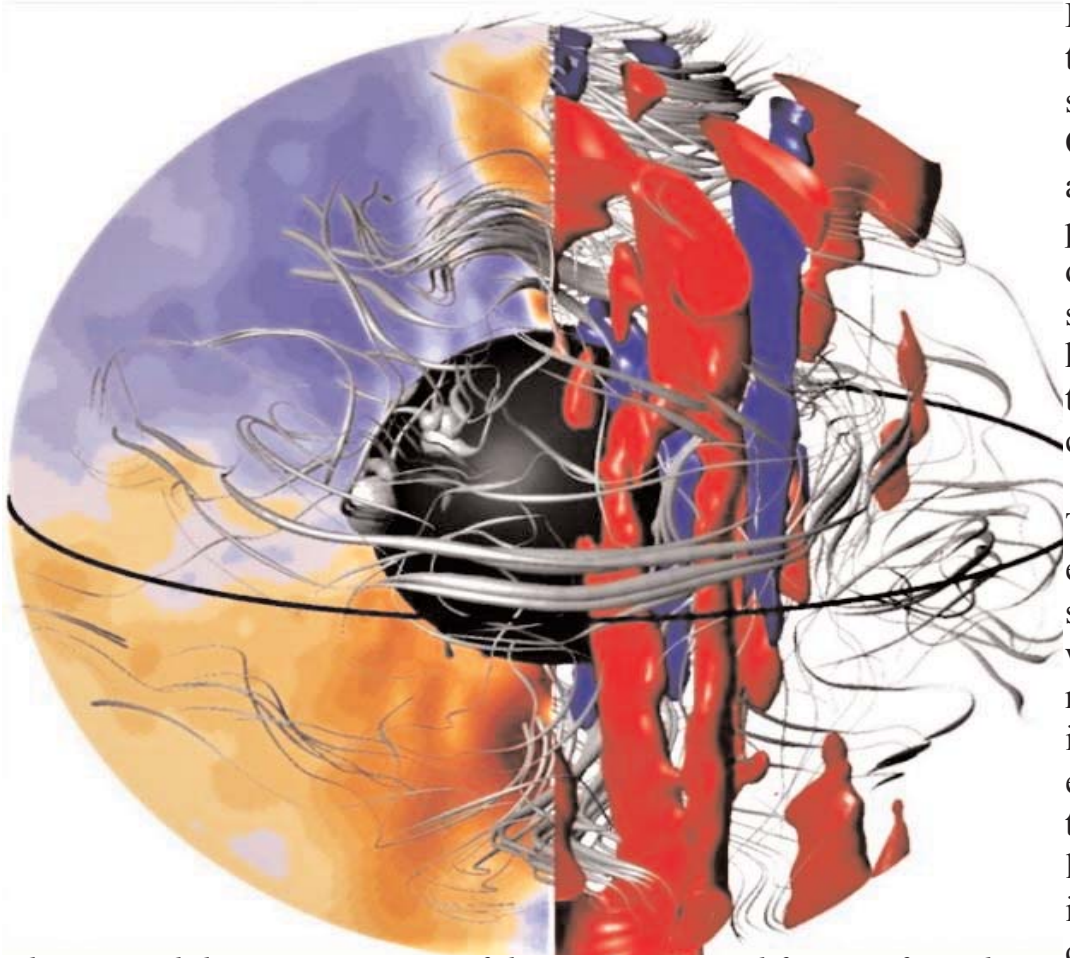
Regarding the convection mechanism, it would indeed be able to support the geodynamo on its own over the long term, but on condition that the thermal conductivity is less than 100 Wm-1.K-1, which has not yet been proven. . The scientists show, however, that the problem is solved if we take into account the exsolution of the light elements which increase this limiting conductivity value by 15 to 200%. As a result, convection, aided by the exsolution of the light elements from the core, would be the mechanism participating mainly in the maintenance and stability over time of the earth's geodynamo. The effect of the tides, which could be significant, is still poorly constrained today, as is the rate of exsolution.

Earth's magnetic field weather forecast
Knowing how to predict the mysterious vagaries of the Earth's magnetic field would be very useful to satellite operators but also in many other areas, since our smartphones carry applications that use a magnetic compass. Modeled on meteorology, a new discipline is being born, which is based on the knowledge of the movements agitating - slowly - the core of the Earth.

Many human technological activities depend on the Earth's magnetic field. Among the fields where knowledge of the spatial and temporal variations of this field is important, we can cite the operation of low-altitude satellites, the determination of the course in navigation applications such as those embedded in smartphones, the geophysics of exploration , as well as the protection of large-scale electrical infrastructure. To give a concrete example, we know for example that the rate of occurrence of failures on satellites increases sharply when they cross an area of weak magnetic intensity known as the South Atlantic anomaly. This is quite expected since the Earth's magnetic field protects our planet less well against charged particles from the solar wind in this area.

How to explain and predict these variations? This field finds its source in the slow cooling of the interior of our planet, which creates convection movements in the core, a ball of liquid iron located 2,900 km below our feet. In such an electrically conductive fluid, the movements generate a dynamo effect, which converts a fraction of the energy released by the cooling into electromagnetic energy. Computer simulations of this geodynamo have been greatly developed over the past two decades and have made it possible to better understand the fundamentals of this mechanism. These simulations are now sufficiently advanced to reproduce the essential large-scale

characteristics and centennial variations of the magnetic field Starting from this state of the art, the question of prediction can be dealt with by taking inspiration from data assimilation techniques, which have mainly been developed in meteorology and oceanography over the last decades. The principle of data assimilation is to direct the evolution of the system simulated by computer calculations by injecting observations into it. For several years, researchers from the Institut de Physique du Globe in Paris and the Institut des Sciences de la Terre in Grenoble have been working on the development of the assimilation of geomagnetic data, with the support of their structures, the CNRS/INSU , Cnes, GENCI and the National Research Agency.



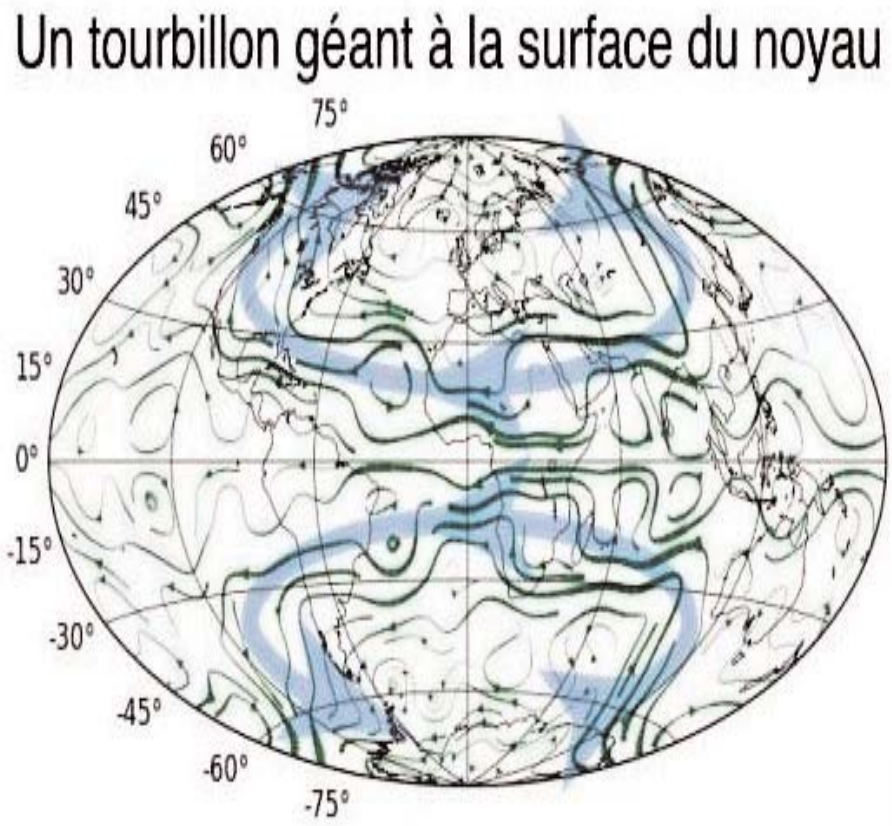
The internal dynamic structure of the core, estimated from surface observations and the behavior of a computer model of the geodynamo. The vortex structures of the flow are shown in red and blue. The internal magnetic field is shown in orange and purple, along with field lines in the volume that are twisted by the flow. © Julien Aubert, IPGP/CNRS

In collaboration with a researcher from the Danish National Space Institute (DTU Space, Copenhagen), representatives of this group have just delivered in two articles published in the journals Nature communications and Geophysical Journal International operational results of this modeling of the geodynamo. This work uses data from the Swarm mission (Esa), a constellation of three geomagnetic measurement satellites launched at the end of 2013.

How to explain the decrease in the magnetic field observed since 1840?
One of the strengths of data assimilation is that it makes it possible to estimate the internal dynamics of the nucleus from surface observations, with the help of statistics (provided by the computer model) which characterize this dynamic.

This approach reveals the presence of a large whirlpool on the surface of the Earth's core, which, like a conveyor belt, permanently transports the magnetic field from the poles to the equator at the level of Asia, and the equator to the poles at the level of America. If the magnetic field were not so asymmetrical between the eastern and western hemispheres, its intensity would remain stable over time. However, the presence of the low-intensity anomaly in the South Atlantic unbalances this mechanism, so that there is a lack of magnetic field returning to the poles, and therefore a decrease in the dipole, which constitutes the bulk of the visible field at the surface. This is the reason why its intensity has decreased since the first absolute measurements made by the mathematician and physicist Karl Friedrich Gauss in 1840.

The question of the decrease of the Earth's magnetic field is therefore intimately linked to the respective position of the vortex and the anomaly in the South Atlantic. Data assimilation simulations predict that these will remain linked to each other over the next century. Under the effect of the strong lateral drift that the vortex creates in the equatorial regions of the Atlantic, the anomaly and the vortex itself should also be pushed about 3,000 km towards the west (on the surface of the Earth) in the next 100 years. This displacement will however not change the mechanism described above, and the decay of the magnetic dipole should therefore continue at the same rate in the next century. The South Atlantic Anomaly will also deepen significantly, widening the problematic area for satellite flight.



Carte centrée sur l'Atlantique de l'écoulement de grande échelle à la surface du noyau, qui s'organise comme un grand tapis roulant provoquant une dérive vers l'ouest. © Nicolas Gillet, IsTerre, CNRS

Can we predict the behavior of the Earth's magnetic field in the longer term, and in particular predict the next pole reversal?? Such reversals occur at a chaotic rate averaging about four events per million years. The last reversal occurred 780,000 years ago. We therefore live under a relatively long period of stable polarity, which however presented multiple phases of magnetic field growth and decay.

To pursue the atmospheric analogy, if the evolution of the South Atlantic anomaly is a matter of meteorology, the prediction of inversions is a matter of climatology, in other words very long-term variations. These are unfortunately unpredictable, due to the famous "butterfly effect" which describes the sensitivity to the initial conditions of a chaotic system. Any error in the initial determination of the state of the system results in an error in the prediction, which grows exponentially as time passes. The doubling time of this error, which for the atmosphere is of the order of a few days, is around thirty years for the Earth's core. Predicting a phenomenon that could occur in the next hundred thousand years is therefore quite simply impossible, just as one cannot know with certainty what the weather will be like next year on the same date.

The geodynamo also exhibits very short-term phenomena such as geomagnetic jerks, or abrupt changes in the rate of change of the magnetic field. Space measurement missions such as Swarm have revealed many of these quakes over the past 15 years, but numerical geodynamo models are still unable to reproduce them operationally, due to limitations in available computing power. An approach combining quality geomagnetic measurements, associated with the progression of simulations, should in the future enable the origin of these still unexplained phenomena to be discovered.

Polar trajectories observed in the most detailed volcanic records. The data comes from superimposed lava flow sequences. In orange, representation of the nucleus with its liquid envelope where the magnetic field and the solid seed are generated. © Valet et al. 2012

The stages of magnetic reversals

Earth's magnetic reversals have occurred multiple times over hundreds of millions of years. But until today, we did not know very well what happened at each change of polarity of the Planet. According to a group of French and American geophysicists, these reversals occur in three stages and in just a few thousand years.

Reversals of the magnetic field occur at irregular intervals that can vary from 100,000 years to several million years. They concern the dipole part of the magnetosphere, ie the part which behaves as if the Earth were a large magnet and which constitutes 90% of the total magnetic field. Earth's magnetic records have revealed that prior to a reversal, this component slowly weakens over tens of thousands of years. The pole shift then occurs in a few thousand years.

From the magnetic poles to the equator

Unfortunately, the archives used so far, mainly those contained in sediments, did not allow us to know with certainty the events taking place during these thousands of years, nor whether characteristics of these inversion phases were repeated each time. . All this information is of course important to constrain theories and models of the Earth's interior, more precisely, what happens in the liquid part of the core where the convection currents stirring the alloy of iron and liquid nickel which constitute it generate the magnetic field of the Earth.

The geophysicists finally found several superimposed volcanic flows, allowing them to have the desired temporal resolution to study the details of the inversion process and this over a period of the age of the Earth between -0.8 and -180 million. of years. They discovered that with each inversion, the same structure returned repeatedly.

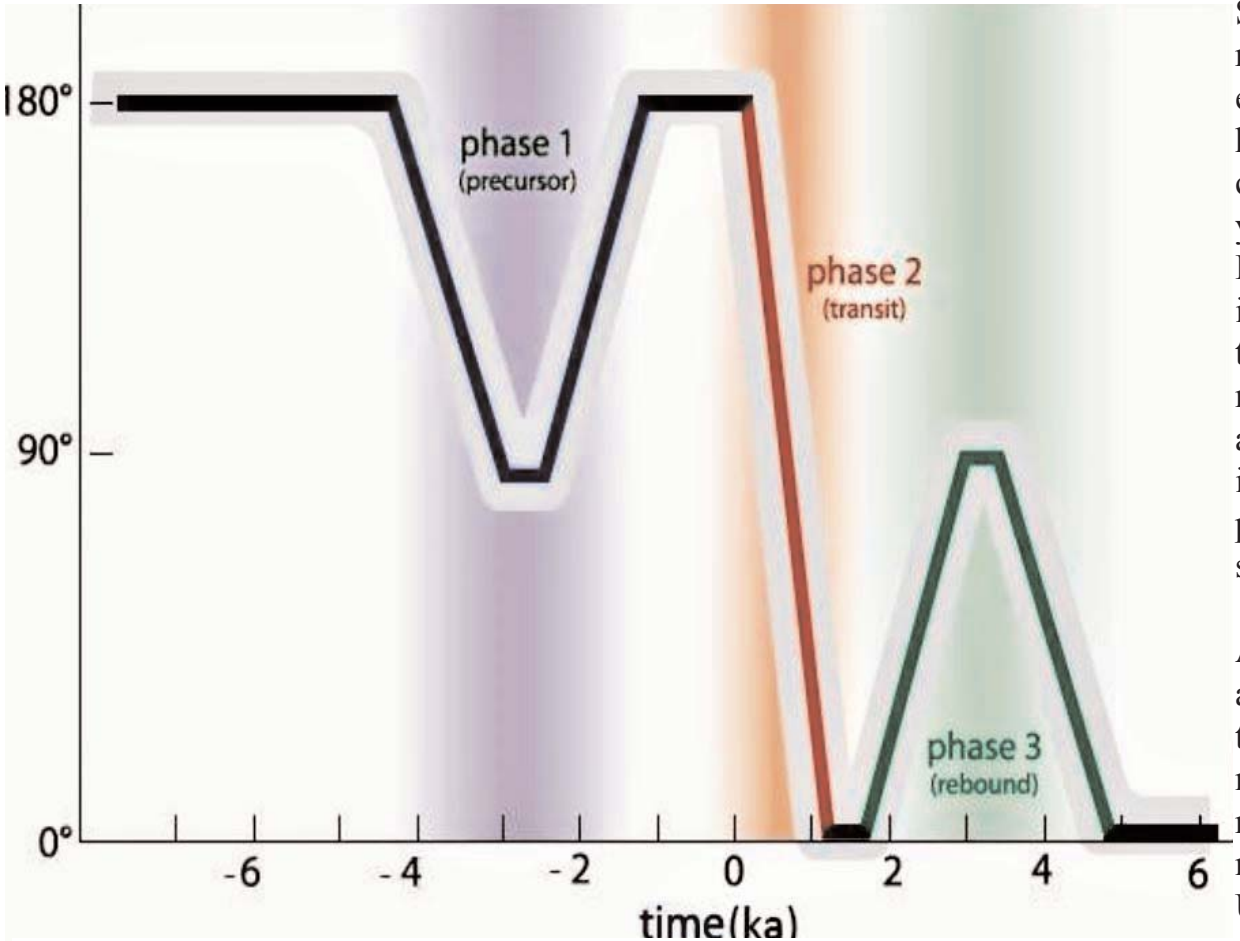
As shown in the diagram above, everything happens in three stages, each of which lasts about 2,000 years. The first is the so-called precursor phase where the pole moves towards the equator before returning to its original position, followed by a phase of rapid transition to a reverse polarity. This reverse polarity is not immediately truly established because a rebound phase follows bringing the poles back towards the equator before they switch again to remain in place while waiting for the start of a new reversal.

Cyclic magnetic reversals?

Since then, geophysicists have made an increasingly deep and precise dive into the Earth's magnetic record and have discovered many magnetic reversals there, but rather chaotically occurring, even if the question of the existence of certain periodicities surfaced from time to time. We see a new example with a publication in the famous journal Proceedings of the National Academy of Sciences.

The magnetic measurements concerned lava samples from flows in the east of Scotland and they were combined with measurements elsewhere on Earth, notably in Siberia. The set of measurements reviewed covers a period ranging from 200 to 500 million years in the past and collected over the past 80 years.

According to paleomagneticians, analysis of these measurements reveals that between 332 and 416 million years ago, the intensity of the Earth's magnetic field was less than a quarter of what it is today, and that A similar period of weak geomagnetism existed about 120 million years ago.



Schematic illustration of the 3 phases (precursor, polarity reversal and rebound) of the magnetic pole reversal process. The time on the abscissa is in thousands of years and on the ordinate is the direction of the field. © Valet et al.

Strictly speaking, the researchers therefore explain that they have highlighted a probable cycle of around 200 million years in the intensity of the Earth's magnetic field, not in its sign. But, they say, this has implications for magnetic reversals because a weakening of the magnetic field is known to often precede a magnetic reversal.

As for superchrons, these are periods in the history of the Earth during which the magnetic field does not reverse for a period of more than 10 million years. Until now, the existence of two periods of this type was consensus and a third remained controversial.

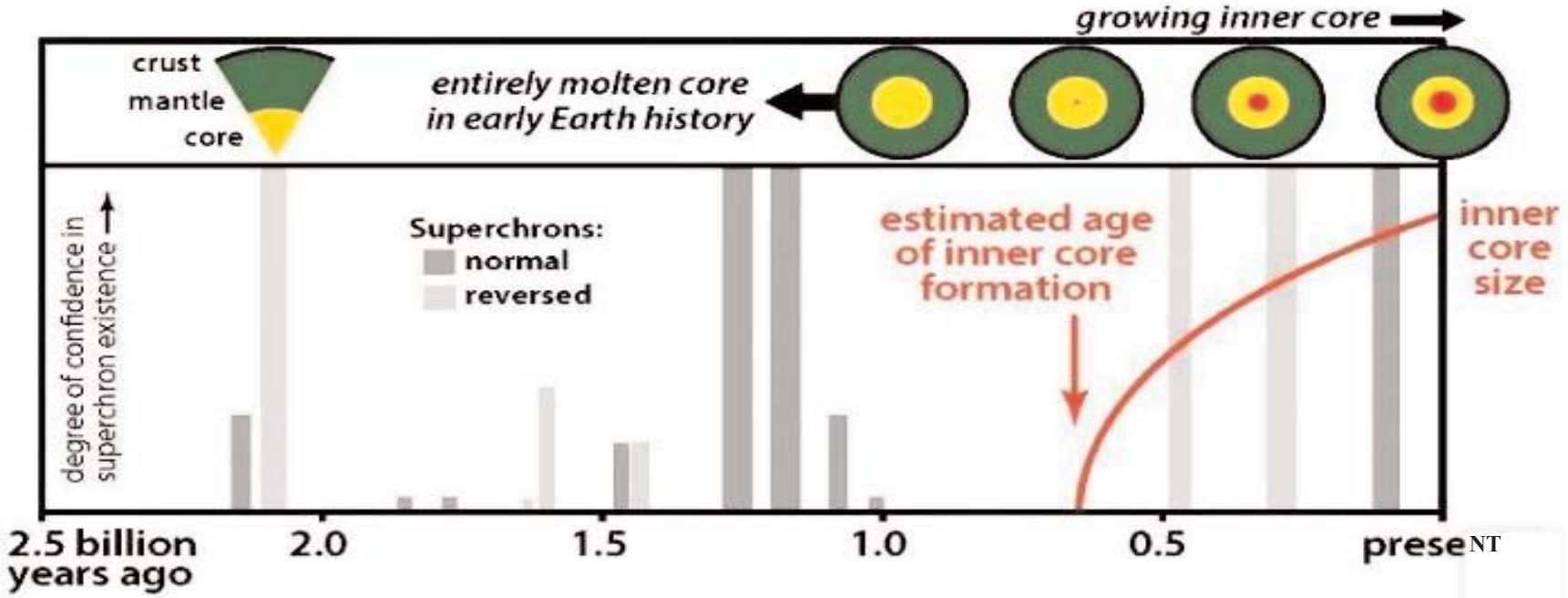
The superchron called Cretaceous Normal lasted almost 40 million years, so there are 120 to 83 million years, that is, during the Cretaceous. The Kiaman superchron (the name Kiaman derives from the Australian village of Kiama, where the first geological evidence for the existence of this superchron was found in 1925) meanwhile lasted approximately from the end of the Carboniferous to the end of the Permian, more precisely from 312 to 262 million years ago.

There would have been ten superchrons during the Proterozoic, a period extending from 540 million years ago to 2.5 billion years ago. If they are correct, the discovery is problematic because these superchrons appear to have occurred on a relatively regular basis. However, according to geophysicists, it was also during this period, about a billion years ago, that the seed of the Earth, the solid part of the core discovered by Inge Lehman, began to crystallize.

According to the numerical simulations of the geodynamo, the quasi periodicity of the superchrons is not credible since it should have been disturbed by the beginning of the genesis of the seed.

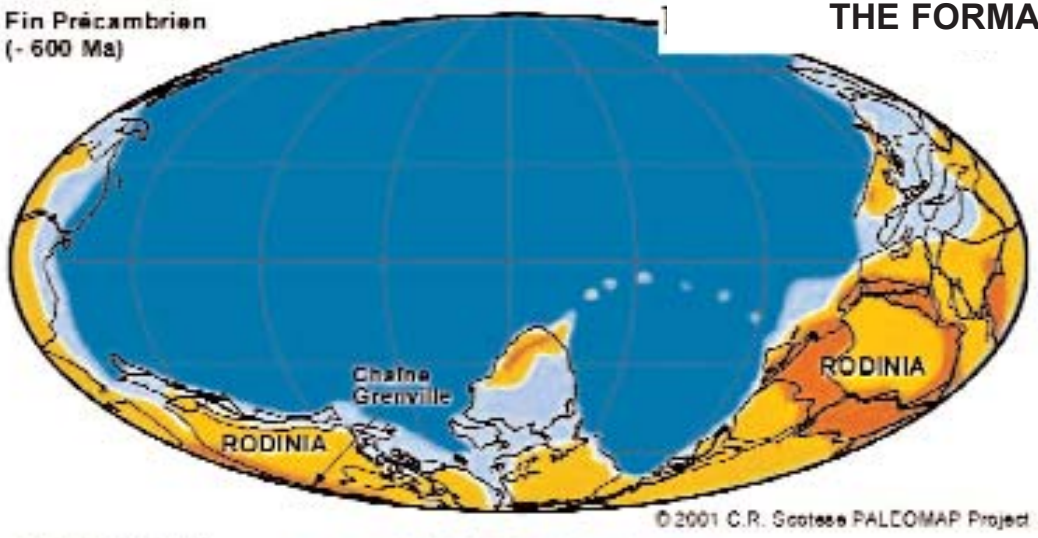
It seems that we are then faced with an alternative: either the formation of the seed is actually older, or the operation of the geodynamo is more stable than the numerical simulations suggest and it has been only slightly affected. by the onset of seed crystallization.

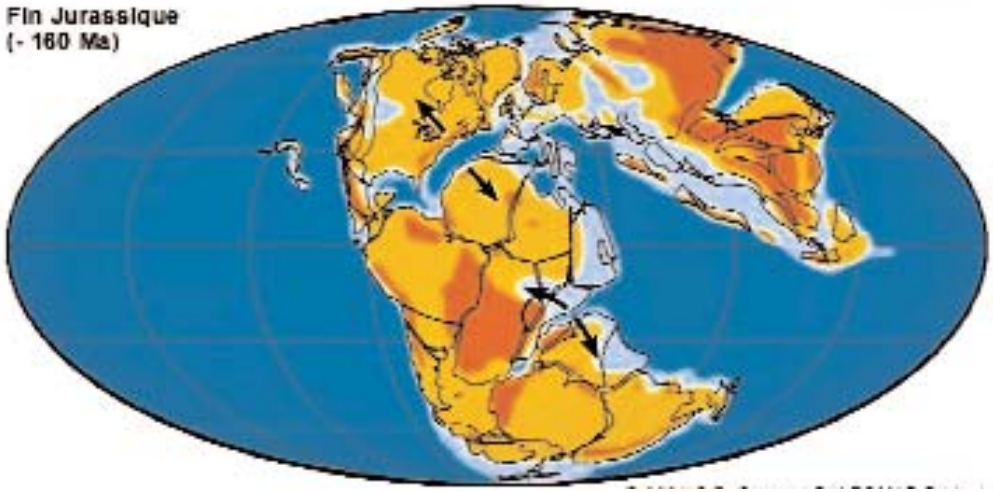
Given the models of the cooling of the Earth which predict this crystallization, it seems that the second hypothesis is the correct one.



Des superchrons sont représentés sur ce schéma chronologique s'étendant sur les deux derniers milliards d'années. Les deux couleurs grises indiquent des polarités différentes du champ magnétique. Plus les barres sont hautes, plus l'existence du superchron est probable. On voit aussi les étapes supposées de la croissance de la graine (*inner core*) du noyau (*core*) de la Terre. © Nasa

THE FORMATION OF GAIA





ORIGINE DE LA VIE TERRESTRE
" Ceinture de roches vertes du Nuvvuagittuq "
ORIGIN OF EARTH LIFE
"Nuvvuagittuq Greenstone Belt"

According to geoscience researchers, the oxidized iron structures reminiscent of fossilized microbial filaments and which have been found in rocks older than 3.75 billion years in Quebec are indeed proof of the existence of living forms already diversified in the past of the primitive Earth. If they are indeed microfossils, some could be more than 4 billion years old, pointing to an early and rapid appearance and evolution of life on Earth.

At the start of the 20th century, there was reason to believe that planets, and indeed planetary systems, must be rarities in the observable cosmos. We now know that they are almost unavoidable around main sequence stars. What about the appearance of life on Earth? A huge stroke of luck with a very slow evolution or on the contrary an equally inevitable and very rapid process, not only perhaps at the beginning of the Archean 4 billion years ago, but already only a few hundred million years ago. years after the birth of our Blue Planet during the Hadean?

Observational techniques using in particular X-rays and expert image processing with powerful computers made it possible to confirm that the hematite filaments were wavy and twisted, and contained organic carbon, characteristics shared with the microbes that eat carbon. modern iron.

From all this data, the researchers deduced that, according to them, the hematite structures could not have been created by the compression and heating of the rocks much later, with a metamorphism that would have operated over the course of billions of years after the end of the Hadean.

The structures observed are indeed made of hematite, a form of iron oxide or rust, and encased in quartz. Their study was renewed by cutting new sections about as thick as paper (100 microns) in the rocks collected in 2008. It was then easier to make comparisons with what can be observed with oxidizing bacteria iron located near hydrothermal vent systems today.

Hydrothermal springs at the origin of life?

In this case, the researchers believe they have discovered microfossils, that is to say the fossilized remains of microorganisms. Previously, the record was held by similar remains found in Western Australia with an estimated age of 3.46 billion years (see also the article below about the possible discovery of fossilized remains of stromatolites built by cyanobacteria 3.7 billion years ago). The supposed Nuvvuagittuq microfossils are in the form of tubes and filaments of hematite (a mineral based on iron oxide) found inside layers made up of quartz.

If confirmed, this discovery would be interesting in more ways than one:

Already, it should be known that the Nuvvuagittuq Greenstone Belt contains sedimentary deposits and other rocks suggesting that it would have formed in a volcanic zone similar to that where, today, we observe hydrothermal hot springs. This can only strengthen in their belief those who think that life appeared in these hot springs. Finally, microfossils at least 3.77 billion years old, and perhaps a few hundred million years older, suggest that life appeared very quickly on Earth.

As a bonus, we can also think that all this provides grist for the mill of those who think that life could have appeared very quickly on Mars, when similar conditions reigned there and there were abundant expanses of liquid water and active volcanism.

Bacteria or mineral structures?

However, caution is called for. This is not the first time that structures reminiscent of the remains of filaments made up of fossilized cells have been discovered. In several cases, it was later realized that these structures may have been created by abiotic processes. It happened with so-called microfossils discovered in Australia.

Researchers are well aware of this. This is why they provided several arguments supporting the thesis that they are indeed microfossils, and not concentrations of hematite produced by changes in pressure and temperature that the rocks containing them would have undergone.

These arguments are:

First, the tubes and filaments have characteristics at the level of the divisions which are similar to those of the tubes and filaments formed by bacteria practicing chemotrophy from the oxidation of iron and which are found today in the vicinity hydrothermal vents. Finally, there is graphite and carbonate and phosphate minerals, also associated with living forms and their fossilized remains.

Understanding how the first continental crust was formed is an intensely debated issue, mainly because of the very limited number of rocks capable of testifying to this early episode in the history of our Planet. However, the construction of continents played a major role in the establishment of life on Earth, by providing primitive organisms with environments favorable to their development.

A group of American and Canadian researchers has unearthed the world's oldest known rock, believed to be 4.28 billion years old. This extraordinary discovery along Hudson Bay would open a fantastic window into Earth's earliest past, shortly after the giant impact that caused the Moon. But doubts remain...

Continents under water

If the age of the oldest continental rocks is estimated at more than 4 billion years, this does not mean that there were at that time areas of emerged land. Because the construction of the continents began well at the bottom of the oceans. And the time it took for the first continental masses to emerge is still widely debated, as well as the mechanisms that favored this crucial step, to say the least. The current consensus is that the subaerial emergence of the first continents began about 2.5 billion years ago and was associated with the initiation of plate tectonics.

Currently, plate tectonics is the main driver of continental uplift, mainly through the subduction/collision mechanism. A study recently published in the journal PNAS and conducted by Australian researchers suggests that the first continent emerged from the waters 3.3 to 3.2 billion years ago, that is to say 700 million years ago. sooner than previously thought.

The cratons, witnesses of the evolution of the first continents

The study is based on the analysis of sedimentary rocks from cratons of Archean age. Cratons represent the oldest areas of continental crust on Earth and are, in fact, the playgrounds of scientists

studying the formation and evolution of the first continents. The authors particularly focused on the Singhbhum craton, present in the eastern part of India but which may have originally been associated with the cratons of South Africa and Western Australia.

The sedimentary rocks studied come from the alteration and erosion of the original continental rocks formed under water, and the dating of the zircons by the uranium-lead method made it possible to estimate their age at 3.3-3, 2 billion years. But what allowed the researchers to develop their new model is the fact that these rocks bear traces testifying to the action of the wind or the waves (ripple-marks), proving the existence of subaerial conditions or shallow marine environments (beach or continental shelf). This primitive continent would therefore have emerged more than 3 billion years ago, a time when it is assumed that plate tectonics did not yet exist.

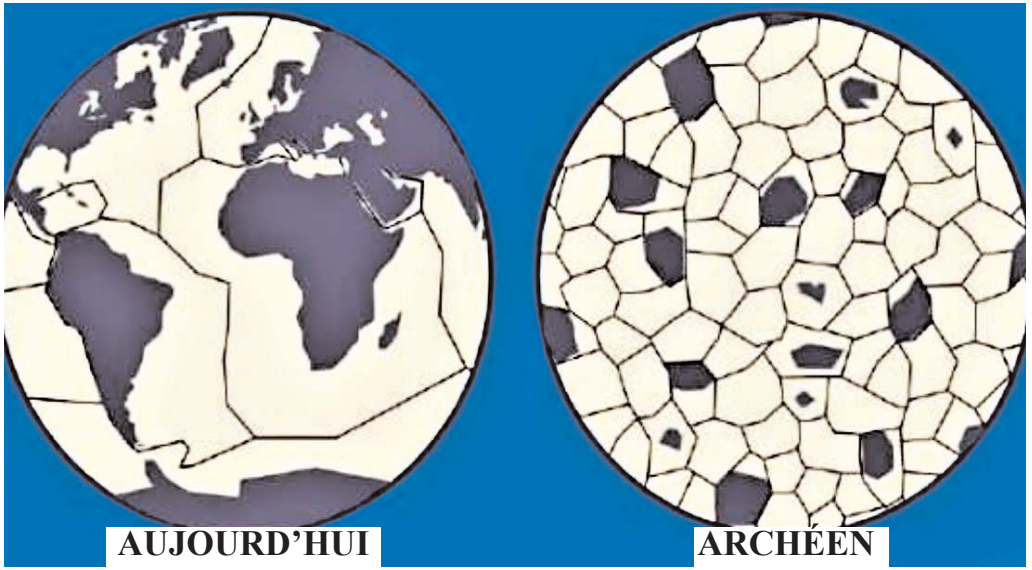
So what happened on Earth during the Hadean period, when the meteoritic bombardment on our planet was still intense? When exactly did the first solid crust form? When did the oceans appear and allow life to begin? Did plate tectonics start very quickly after the appearance of solid crust and how much more active was it than today?

To answer all these questions, it would be necessary to have rock samples dating back more than 4 billion years. We have of course indirect information, in particular thanks to grains of zircon, an exceptionally resistant mineral, which were found in rocks younger than their age of 4.36 billion years, in the west of the Australia. It would even seem that some of the famous gneisses of Acasta, still in Canada, are 4.03 billion years old. But it would take better and it is therefore a truly extraordinary discovery that Jonathan O'Neil, doctoral student in the department of planetary sciences of the famous McGill University in Canada and Richard W. Carlson of the Carnegie Institution for Science in Washington have just made.

How did the formation of the continental crust begin? Emerging from the oceans more than four billion years ago, like Iceland, geologists thought without having proof. The discovery of a gneiss from the famous region of Acasta, in the far north of Canada, has just made this hypothesis more credible.

The Earth has kept almost no geological record of its first 500 million years, which is roughly the geological period called the Hadean. It seems, however, that between -4.568 and -4.4 billion years ago, our planet formed its core and its mantle, and that there existed for a time a gigantic global magmatic ocean.

As the meteoritic bombardment continued to wane, the Earth would have begun to form continental protocrust between -4.4 and 4 billion years ago, as evidenced by zircon crystals found in rocks at Jack Hills in Australia. When the Archean began, around 4 billion years ago, it is estimated that there was only between 10 and 15% of the volume of present-day continental crust. But during this period, which will end about 2.5 billion years ago, intense magmatic activity led to the extraction of nearly three-quarters of the volume of continental crust from the mantle.

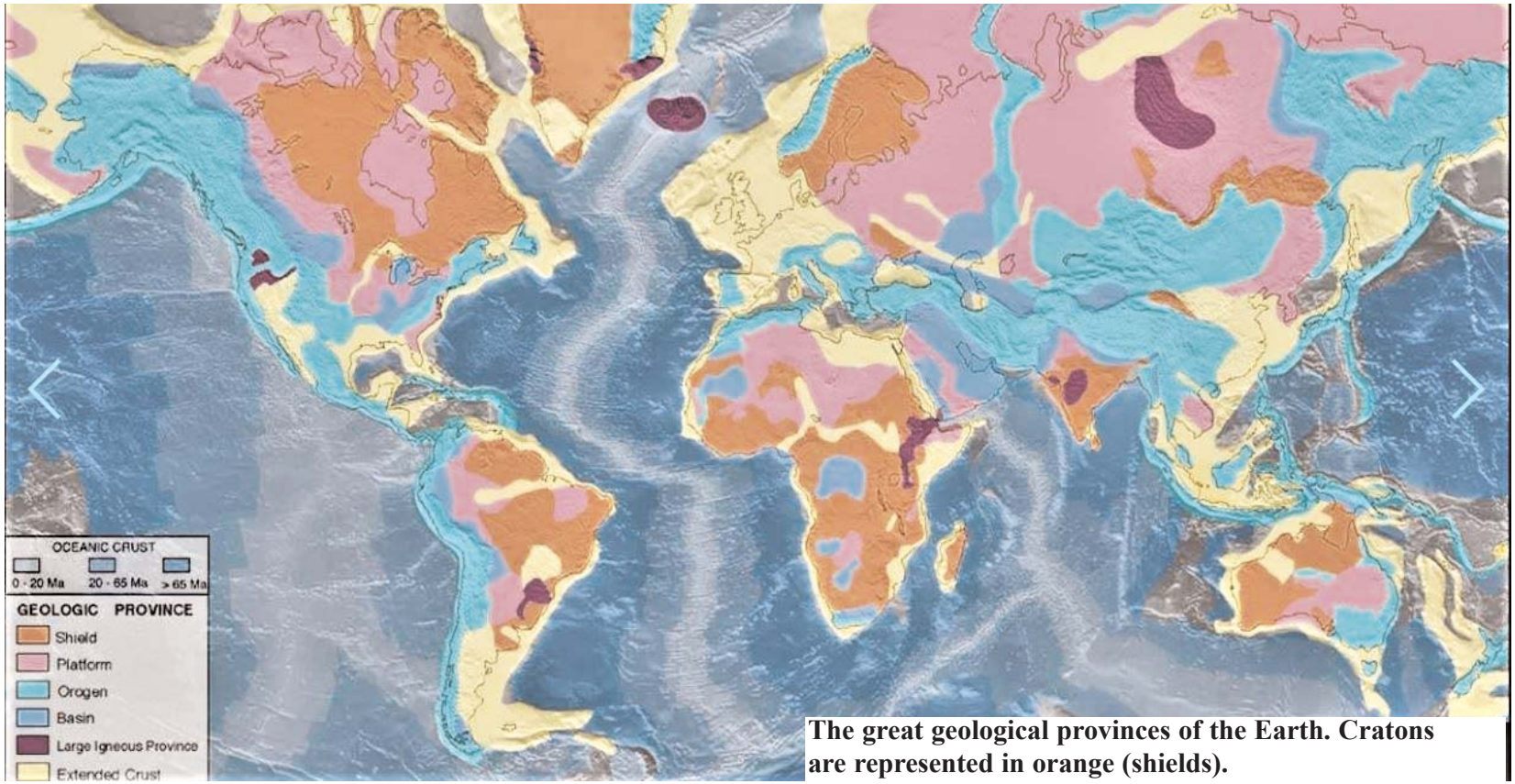


Isostasy, driving the emergence of the first continents

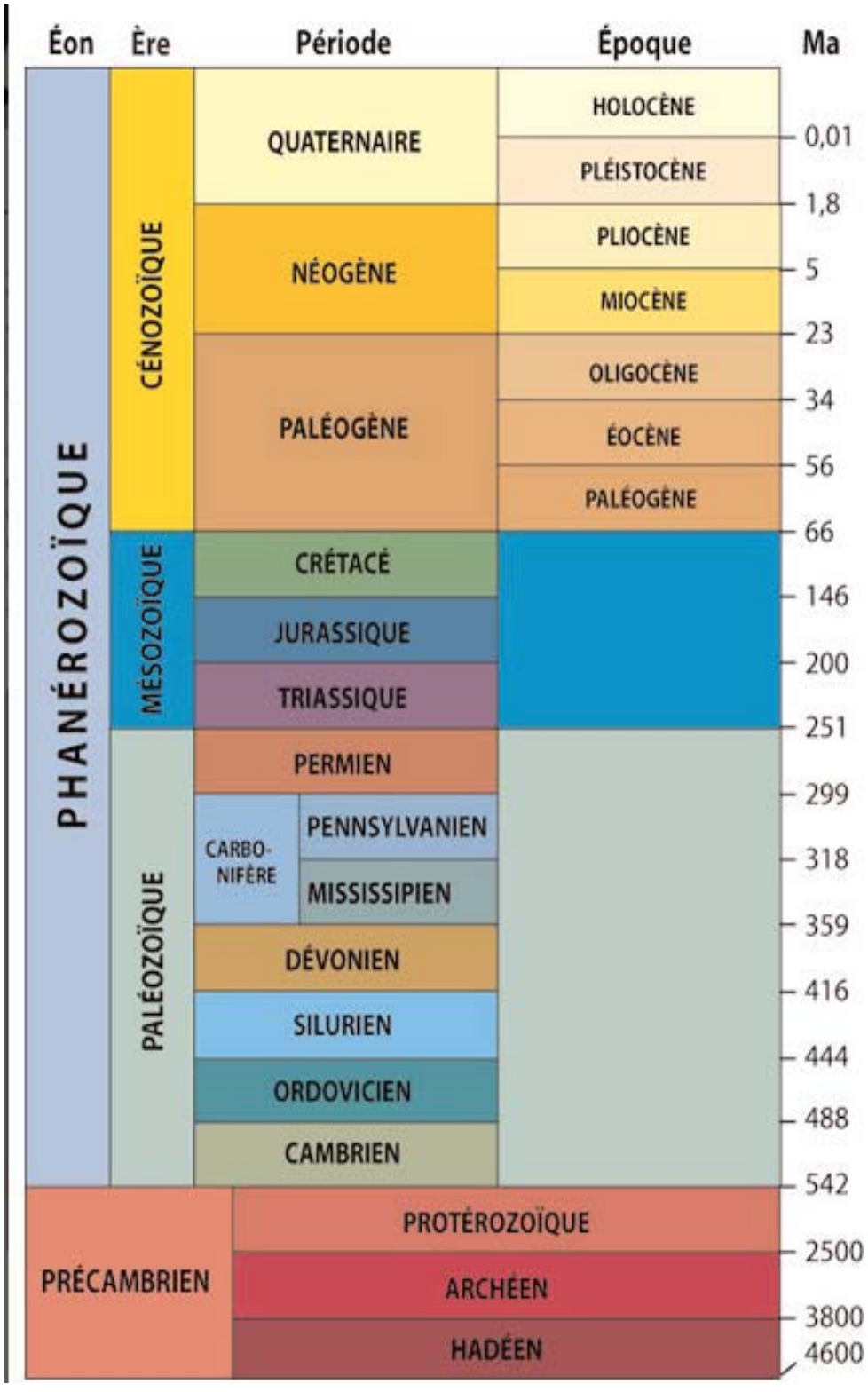
The authors of the study therefore suggest another scenario to explain this early continental emergence. The Singhbhum craton would have formed under the surface of the oceans, by progressive piling up of lava, until reaching 50 km in thickness. 300 to 400 million years of continuous volcanic activity would thus have been necessary to build this submarine plateau, the future continent. But how did this primitive continental crust emerge? The authors then invoke the principle of isostasis, which can be represented as Archimedes' thrust applied to terrestrial material.

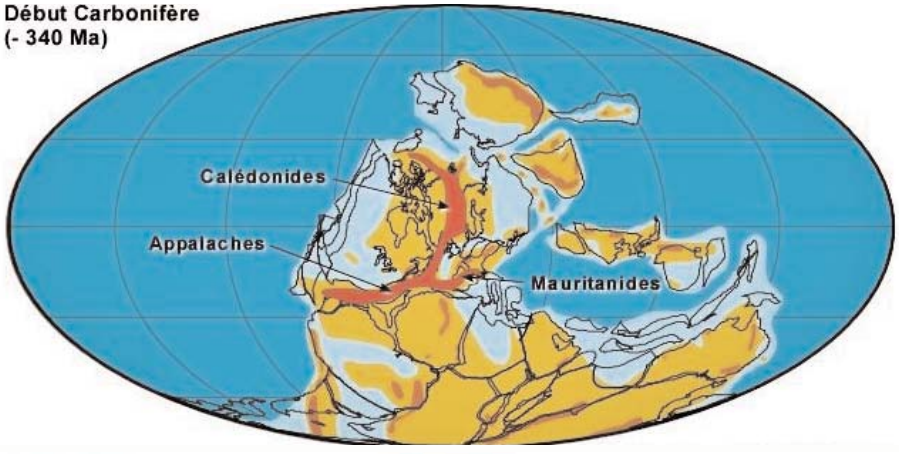
The upper mantle is dense, much more so than the rocks forming the continental crust. If, initially, the weight of the magmatic plateau under construction causes it to sink into the underlying mantle, the laws of isostasis mean that the latter will tend to rebalance and push the continental material, less dense, upwards. This process, which is independent of plate tectonics, could explain how the first continents quickly emerged.

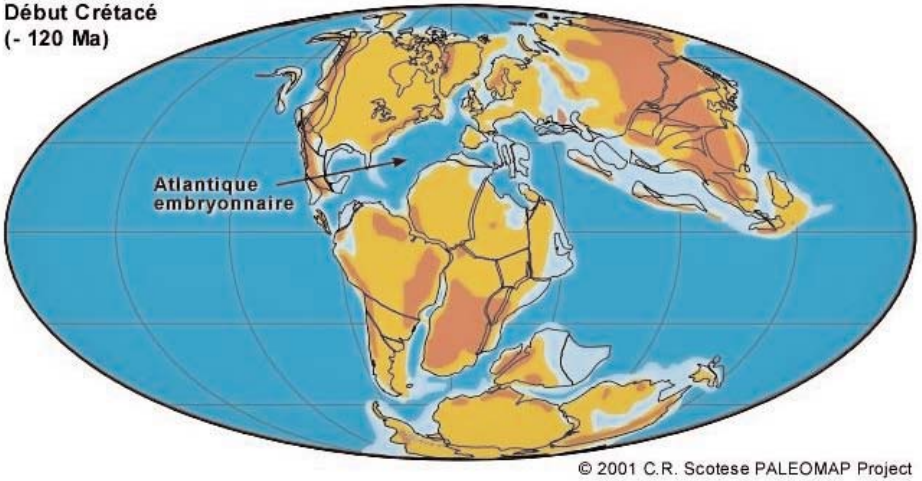
But, who says emerged land also says creation of lagoon and coastal areas, shallow and protected environments, conducive to the development of life. In addition, the erosion and weathering of this very young continent would have brought a significant amount of nutrients to the ocean, such as phosphorus and other basic elements necessary for the development of marine life. The researchers thus associate continental emergence with a significant increase in oxygen production. This step would also have had the effect of pumping atmospheric CO2, generating cold climate zones and the formation of the first glaciers. An essential first step towards the habitability of the Earth.



The great geological provinces of the Earth. Cratons are represented in orange (shields).







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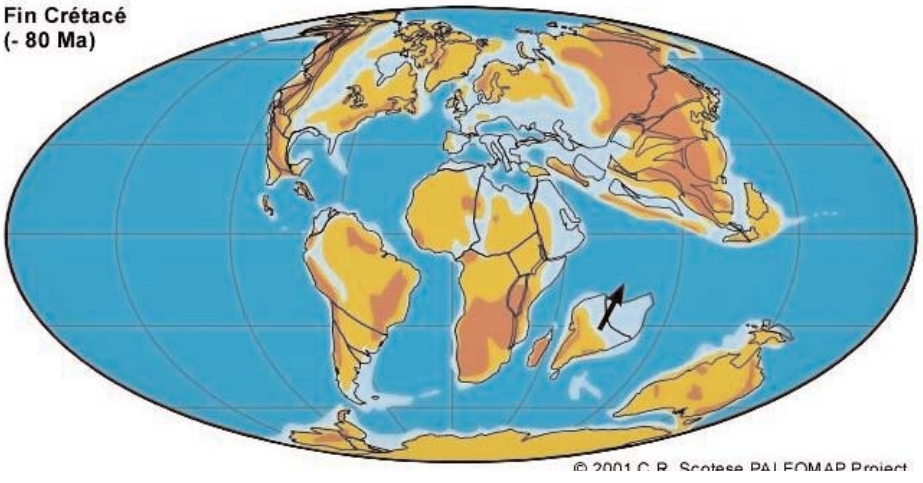

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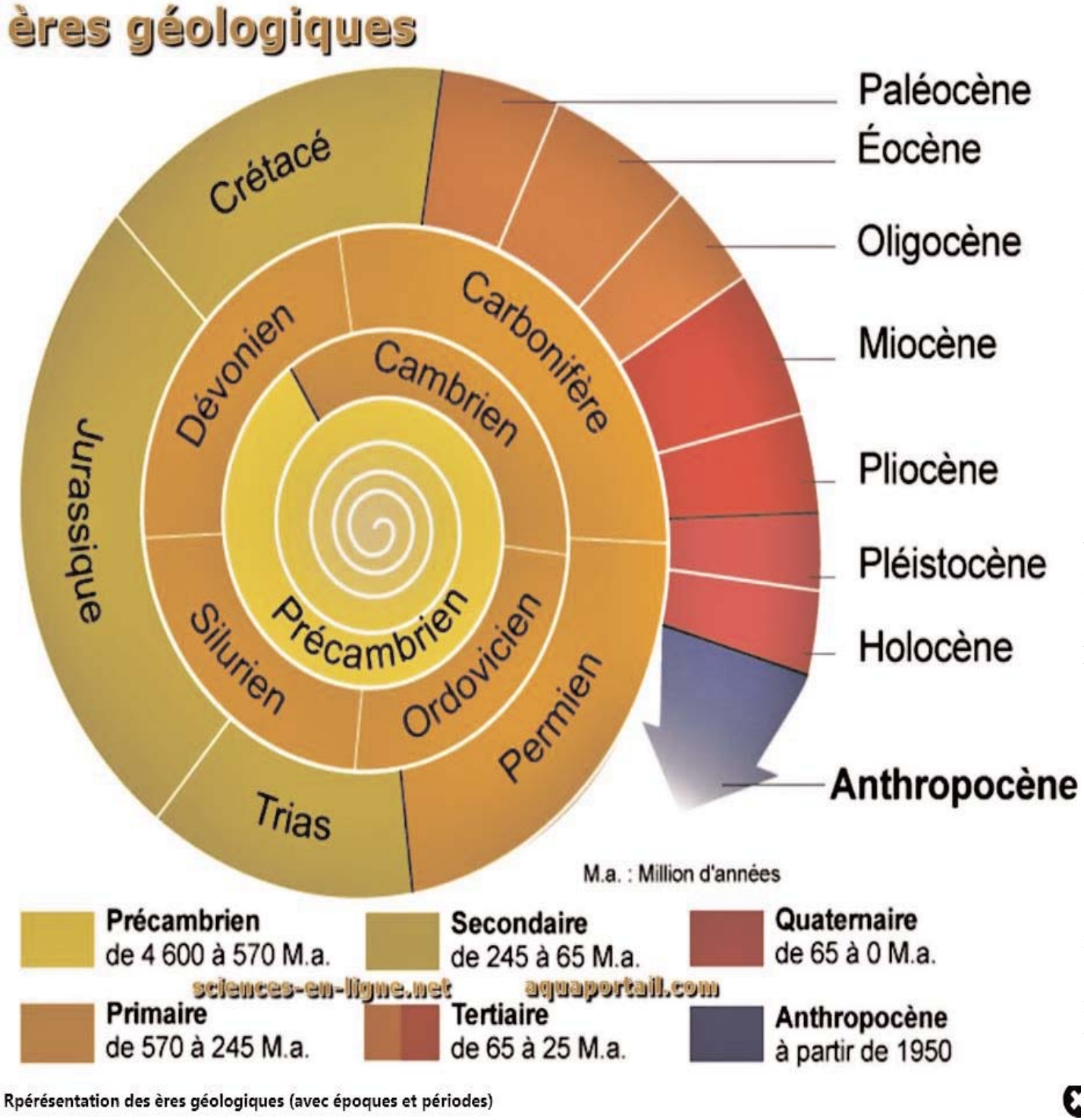


Rpérésentation des ères géologiques (avec époques et périodes)

The Precambrian (3.8 billion to 545 million years):

The Precambrian is the oldest geological period in the history of the Earth (from -0.54 to -4.56 billion years), during which the birth of life took place. It includes the Archaean and the Proterozoic era. The Precambrian refers to the oldest eon in the history of the earth, preceding the Cambrian period and the Phanerozoic eon.

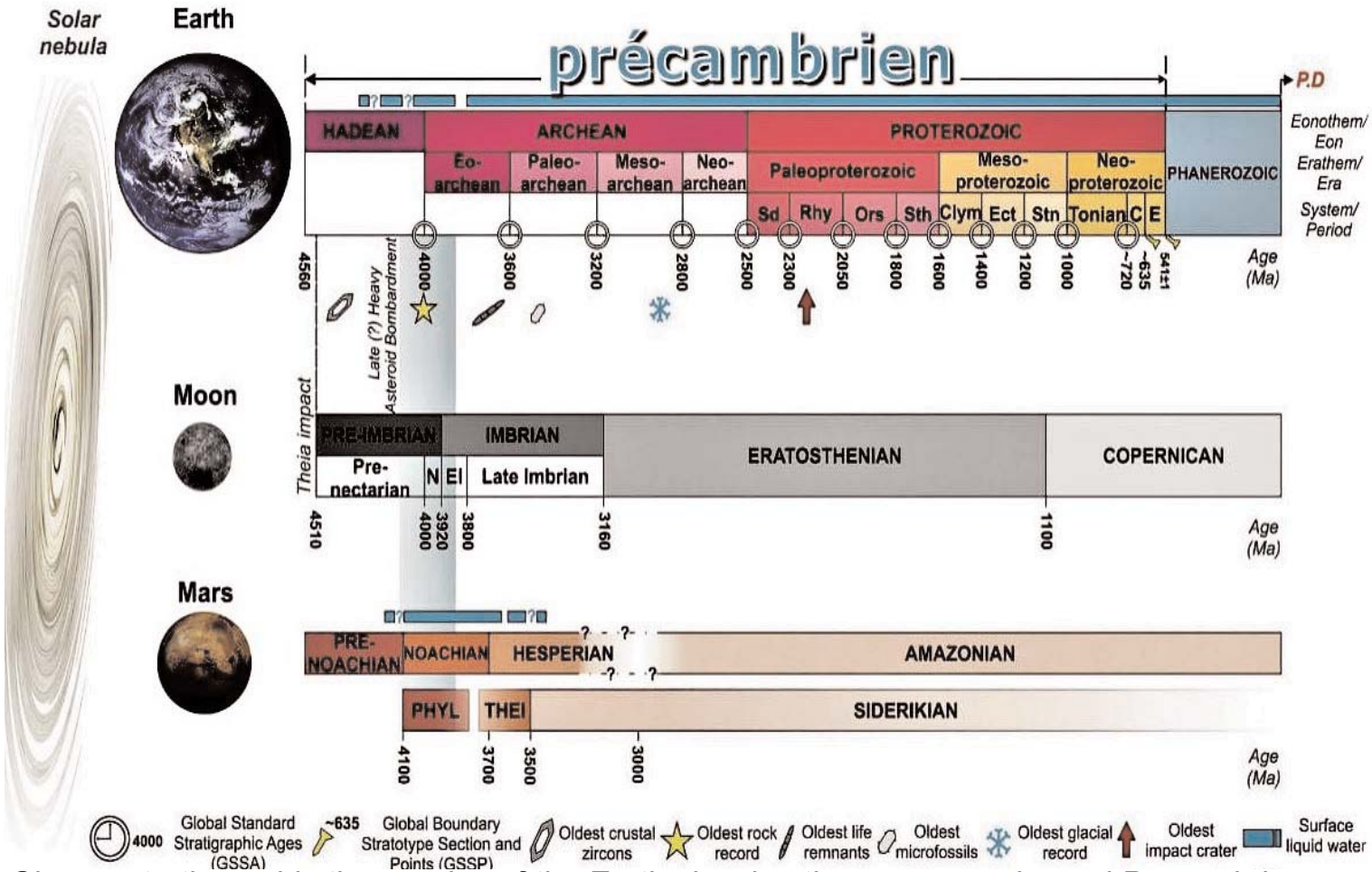
70% of the dominant Precambrian flora and fauna perished during the first great extinction. At the end of the Precambrian, more complex life forms begin to appear. The fossil record of Precambrian multicellular animals includes three main groups that have persisted to the present day. These include sponges, cnidarians (including sea anemones, corals, and jellyfish), and annelids, or segmented flatworms.

The Precambrian is the oldest of the geological ages, which are marked by different layers of sedimentary rock. Deposited over millions of years, these rock layers contain a permanent record of Earth's past, including the fossilized remains of plants and animals buried when the sediments were formed. Some of the oldest rocks in the world - up to 3.5 billion years old - are found in Precambrian rocks. Examples include

gneiss, granite, iron formation, shale, basalt, gabbro, and anorthosite.

The Precambrian is the largest period of time in Earth's history before the current Phanerozoic eon (the largest division of geologic time, comprising two or more eras) and is a supereon divided into several eons on the scale of geological time.

Precambrian is an informal term widely used in scientific literature to describe much of the geologic time scale, spanning from 4560 to 541 million years ago. With boundaries marking respectively the origin of Planet Earth and the appearance of fossils suitable for a systematic biostratigraphic correlation, this interval corresponds to almost 88% of the existence of the Earth. Although it is difficult to identify its origin, the term Precambrian has been applied informally since the mid-19th century, immediately after the establishment of the Cambrian period by English geologist Adam Sedgwick in 1835.



Chrono-stratisgraphic time scales of the Earth showing the eons, epochs and Precambrian system separated by world standard stratisgraphic ages and the only section and point of ratified world boundary stratotypes. Some of the oldest known geological records are also identified in the timescale, which is presented from a solar system perspective and compared to the geological timescale of the Moon and Mars.

Terms like Protozoic, Azoic, and Cryptozoic have also been found in the literature as synonyms for Precambrian. However, since most of them have been defined to describe an ancient rock record lacking evidence of animal life or in which the existence of fossils is "cryptic", the increasing advances in Precambrian paleontology over the past century have rendered these terms inaccurate or obsolete. Although less common, the term Pre-Phanerozoic can also be found in some textbooks and scientific papers as an equivalent of Precambrian.

The Precambrian has been approached in different ways over the past decades. By dividing deep time into formal intervals that mark significant geological events and processes recorded

around the world, the chronostratigraphic diagram aims to synthesize and enhance understanding of Earth system evolution, as well as to create a common language for international scientific and non-scientific communication. Most of its subdivisions are defined based on global reference points defined in the Geological Rock Record, Section and Global Boundary Stratotypical Points (GSSP).

Although these points have been successfully established throughout the Phanerozoic eon at different levels, their recognition in the Precambrian rock record remains difficult. The main limitations result from, among other things, the relatively poor and scattered preservation of rock units and paleontological records, the long and polycyclic post-formation geologic history, and the absence of index fossils in most Precambrian units. For these reasons, several classification schemes based on different criteria and contrasting geological records around the world have been proposed for this time interval in recent decades.

Regardless of the ongoing and active debate over the appropriate criteria to be used for subdividing the Precambrian in the chronostratigraphic time map, recent advances in geosciences and related subjects have enabled the first attempts to divide it according to complete chronometric intervals. These intervals are currently organized at the level of eons (eothemes), eras (erathemes) and periods (systems), which are mostly bounded by arbitrarily defined ages (i.e. the world standard stratigraphic ages, GSSA). Although still in need of appropriate improvements, the current Precambrian classification scheme considers some of the following:

(i) major tectonic, sedimentary and magmatic cycles affecting the Earth system from its earliest evolutionary stages and
(ii) Late Neoproterozoic paleoclimatic and paleobiological events of global significance.

The image above summarizes the time intervals currently established for the Precambrian, which encompasses the Hadean (ca. 4560-4000 Ma) and formal Archean (4000-2500 Ma) and Proterozoic (2500-541 Ma), as well as the aeons of lower rank. divisions. In order to facilitate translation into different languages, the nomenclature available is mainly derived from classical Greek.

The primary or Paleozoic era (545 to 245 million years ago) which ends with a great wave of mass extinctions:

The Paleozoic is a geological era extending from -541 to -251 Ma. This name, given to the primary era, groups 6 systems: Cambrian, Ordovician, Silurian, Devonian, Carboniferous and Permian. Its total duration is about 300 million years. Also important, there were two ice ages in the Paleozoic. Paleozoic means "epoch of ancient life".

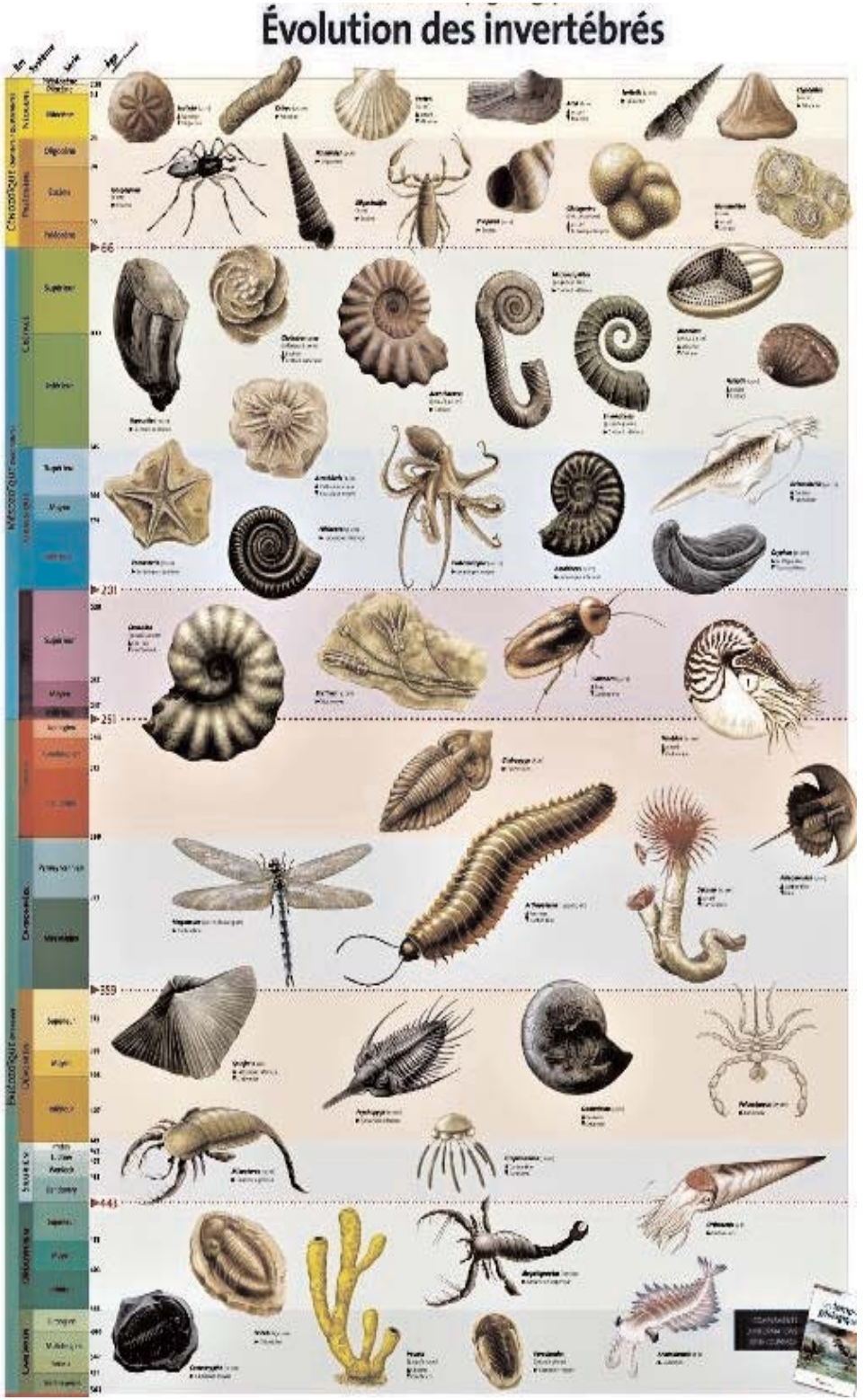
The beginning of the Paleozoic era is characterized by a great diversity of marine invertebrate animals. Primitive fish and reptiles, land plants, and insects also first appeared during this time.

At this time, all major invertebrates appeared along with fish and amphibians. But the animal that dominated the Paleozoic era was mainly fish. The Middle Paleozoic is known as the Age of Pisces. Two major groups of fish were present during the Middle Paleozoic, the jawless fish and the jawed fish.

By the end of the Paleozoic era, evolution had brought about complex land and sea animals. However, the event that marked the end of the Paleozoic period was the mass extinction that wiped out nearly 96% of all marine life and 70% of land animals. Only a few species survived, including some reptiles.

The creation of the Earth began about 4.6 billion years ago. 5 major events occurred at this time: (1) the formation of the Sun and light, (2) the creation of the Earth, (3) the creation of the atmosphere by volcanic degassing, (4) the creation of oceans, and (5) the creation of life.

The Paleozoic began with the Cambrian Period, 53 million years ago best known for ushering in an explosion of life on Earth. This Cambrian explosion included the evolution of arthropods (ancestors of today's insects and crustaceans) and chordates (animals with rudimentary spinal cords).



The secondary or Mesozoic era (-245 to -65 Ma) which ends with the disappearance of the dinosaurs:

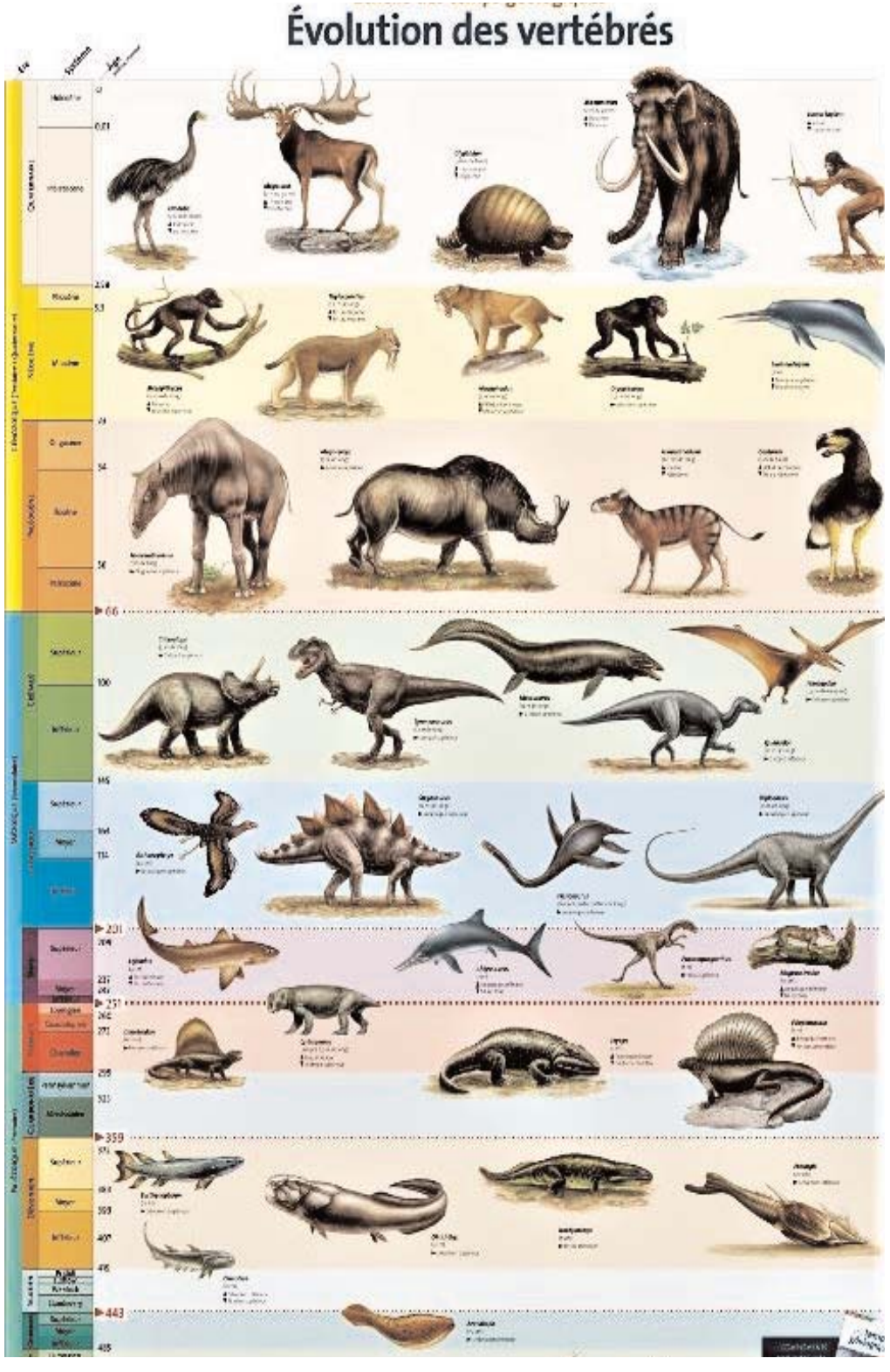
The Mesozoic is a geological era extending from -66 to -252 Ma. This name given to the secondary era includes the Triassic, Jurassic and Cretaceous systems. This era is the middle Phanerozoic period in Earth's history, preceded by the Paleozoic and followed by the Cenozoic. Plants classified as mesophytes date from this era.

Life in the Mesozoic Era:
The Mesozoic began after an ecological catastrophe (Permian-Triassic boundary) at the end of the Permian (at the same time the end of the Paleozoic), the cause of which is not yet clear. During this largest known mass extinction in earth's history, between 75% and 90% of all animal and plant species disappeared. This allowed the evolution of a new type of fauna and flora. The Mesozoic (as a geological age) is also called the secondary era, the age (era) of reptiles and the age (era) of conifers.

Mesozoic geology:
While at the beginning of the Mesozoic all the continents were united in a "supercontinent" (Pangea), towards the end of the Cretaceous, the continents which separate gradually take their current constellation.

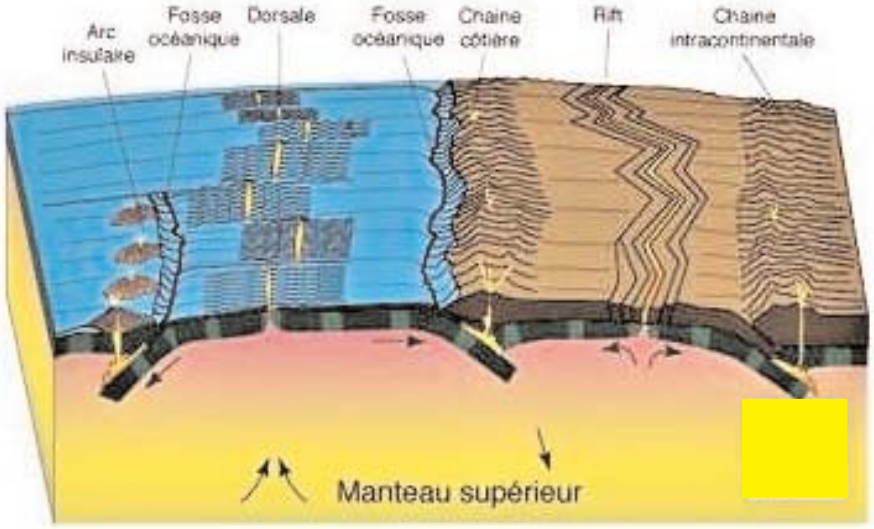
During these 186 million years, there were no major orogenic episodes. Pangea is gradually fragmenting and the continents are moving towards their current position. The climate was exceptionally warm throughout the period, playing an important role in the evolution and diversification of new animal species.

The Mesozoic climate:
With the successive breakup of the ancient supercontinent Pangea, the climate of the Mesozoic era was subject to constant change.



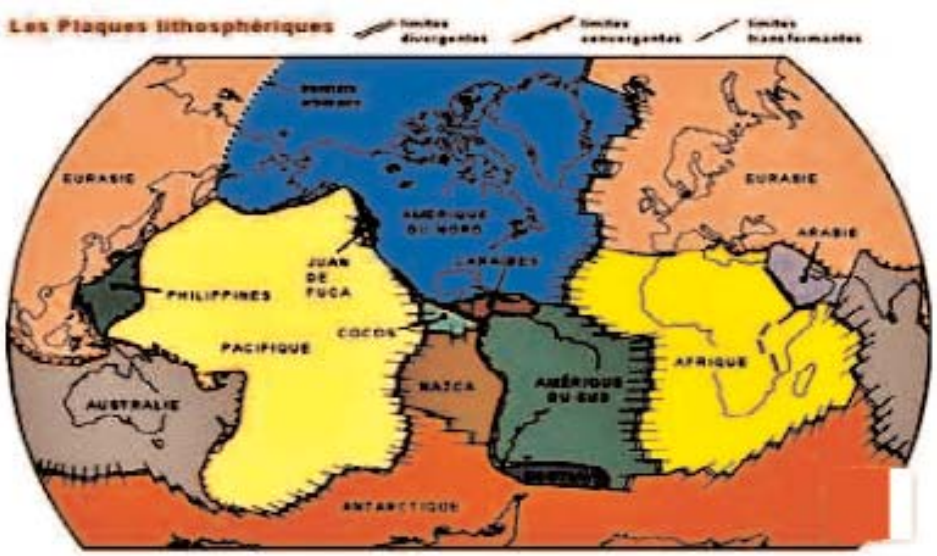
The fragmentation of Pangea

With the beginnings of the formation and the drift of the continents, an important geologic phenomenon appears: the earthquake due to the movements of the tectonic plates.

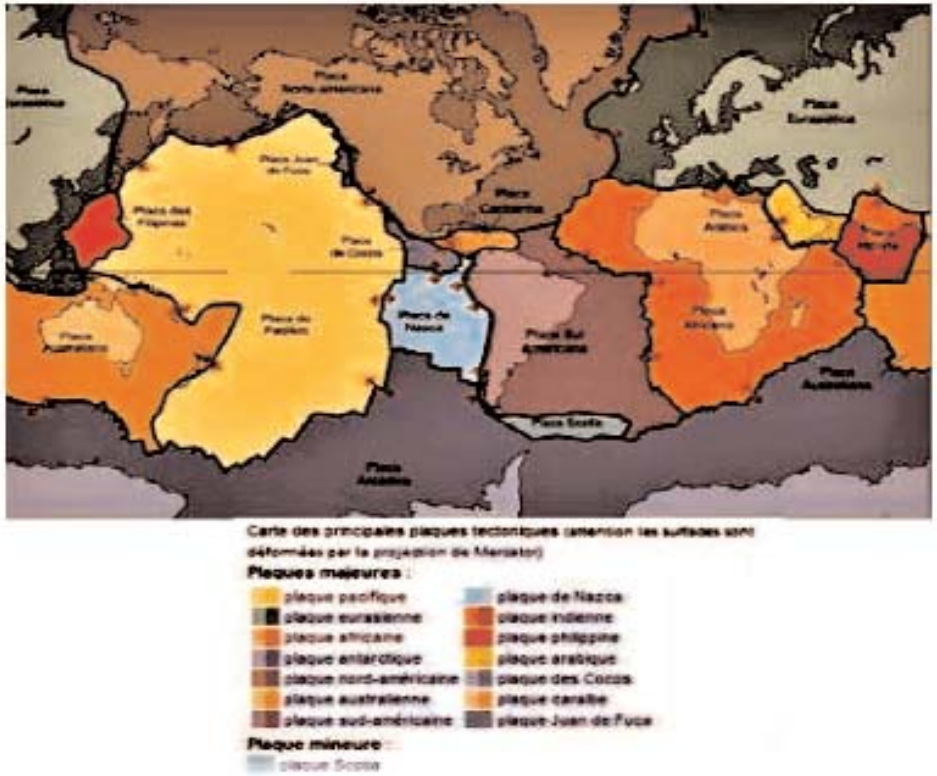


These catastrophic manifestations of the internal life of the earth do not have a random distribution. They are mainly localized along plate boundaries of plate tectonics.

It is in these zones that most of the stresses resulting from the displacement of the plates relative to each other accumulate. These stresses accumulated over time, for tens, hundreds, thousands of years will be released instantly in the form of seismic energy. This will produce a rupture (or "break") and a violent displacement. These faults constitute either ruptures of the earth's crust, or plate limits or boundaries. The "scar" affecting the ground represents the co-seismic rupture, that is to say the sudden displacement of the ground surface which occurred instantaneously during the earthquake.

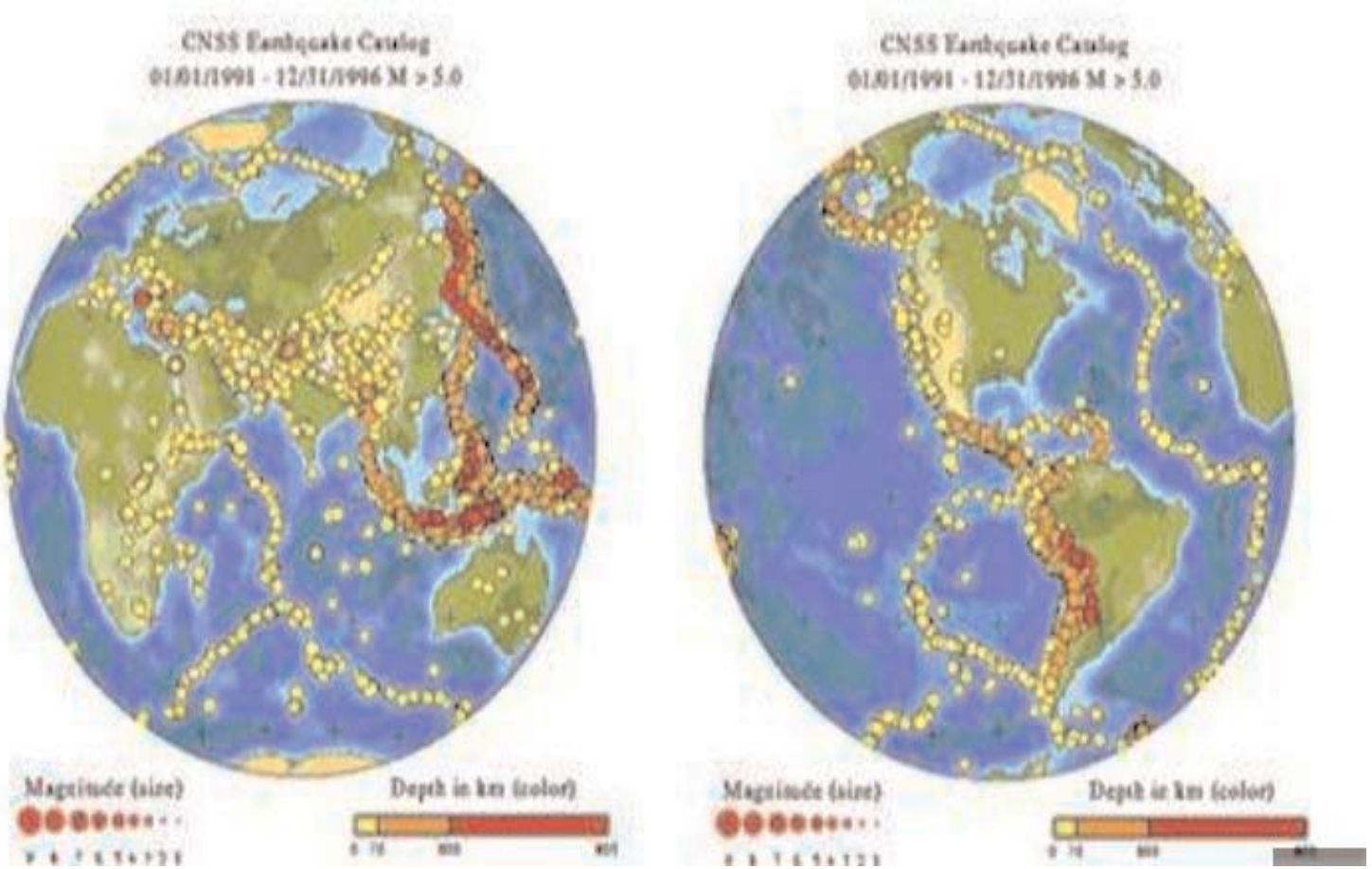


Earthquakes therefore correspond to the initiation and propagation of a rupture along a pre-existing discontinuity of the lithosphere, the faults. These faults constitute either ruptures of the earth's crust, or plate limits or boundaries.



At the beginning of the 20th century, Alfred Wegener noted that the continents had drifted relative to each other over geological time (i.e. on time scales of the order of several million years. 290 Millions of years ago, all the continents were united in a single area of emerged Earth, an immense continent: "Pangea".

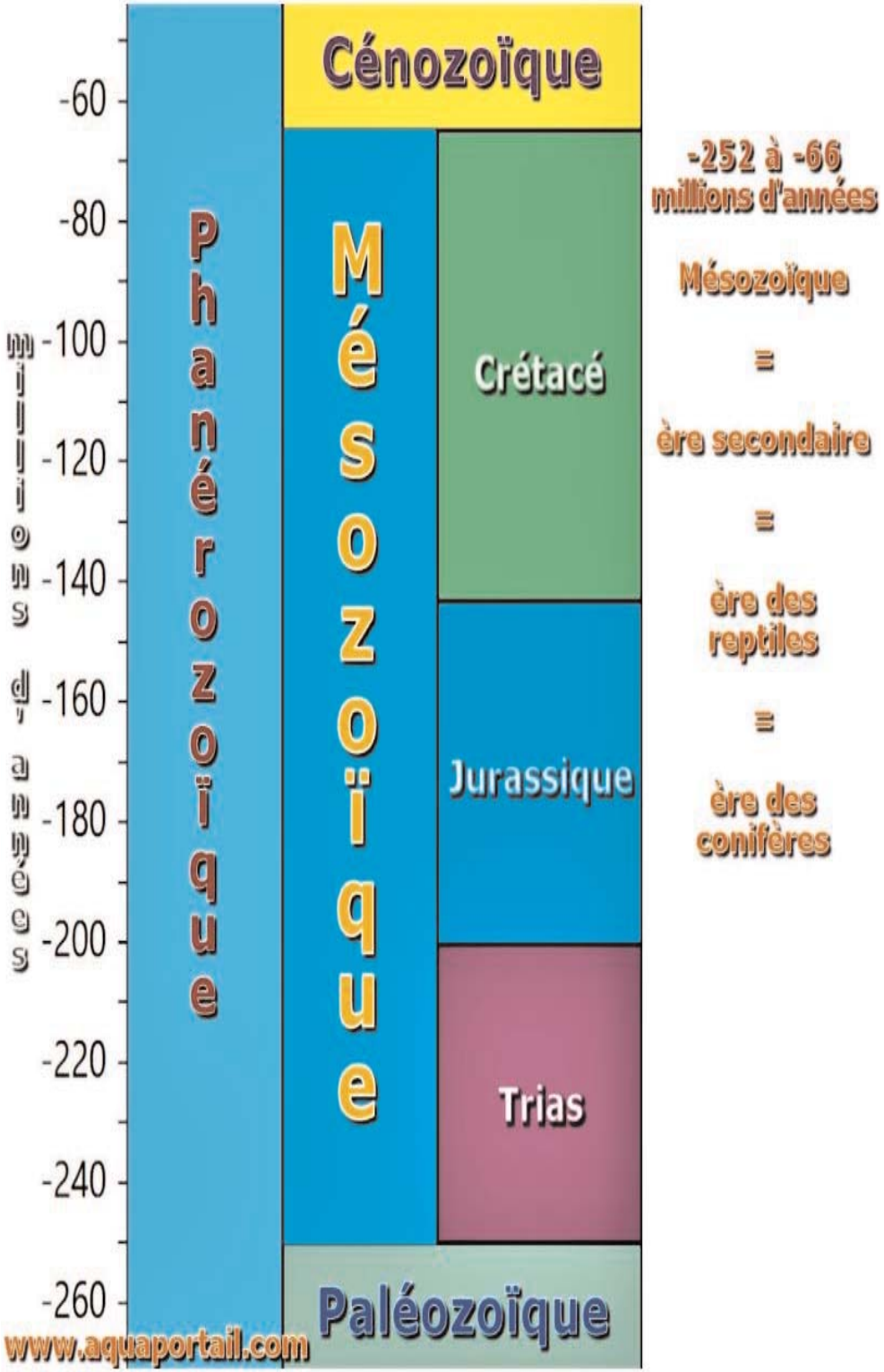
As proof of this phenomenon, the shape of the continents, certain current coast lines corresponding like a real puzzle. Just look at the shape of the African and South American continents to be convinced. This concept of "Continental Drift", stated by Wegener and very controversial for more than fifty years, served as the basis for the current model of "Plate Tectonics".



Répartition de la sismicité et tectonique des plaques

Geodesy is a very old science which aims to measure the shape and size of the Earth. Three centuries BC, a Greek geometer, Eratosthenes, had already determined the radius and circumference of the earth with relative precision, based on the length of the Egyptian stadiums (a measurement frequently used at the time!) .

It was in the 1970s that, thanks to the observation of the ocean floor, scientists formulated this model which makes it possible to explain the global dynamics of the Earth and the distribution of earthquakes and volcanoes. Lithospheric plates move relative to each other at speeds of a few centimeters per year. They are bounded by plate boundaries. The major part of the seismic energy released on the surface of the globe is therefore released at these plate boundaries, such as subduction zones, mid-ocean ridges, or even transform faults..Geodesy also makes it possible to position a point in three dimensions on the surface of the globe. The space adventure will then revolutionize this science. Indeed since the advent of space geodesy (that is to say instruments on board satellites), this science has undergone a real revolution by allowing a considerable improvement in the measurement and therefore in the position of points at the surface of the earth.



At the beginning of the era, there are still huge deserts due to the enormous area of Pangea - comparable to the Sahara in Africa today (see continental climate).

With the emergence of Tethys at the start of the Mesozoic era, however, the climate quickly became wetter and the continents began to split. The climate became tropical as a whole and was very similar throughout the world, as the sea was not yet divided into the Atlantic Ocean and the Indo-Pacific Ocean as the World Ocean is today, and the ocean currents could be distributed more evenly. Even the poles were free of ice.

It was only with the formation of the Atlantic and the beginning of the disintegration of Pangea into the Jura continents that the global ocean currents were interrupted and the global balance of climatic zones did not materialize. This can be seen from the annual rings of petrified wood. Towards the end of the Cretaceous, there were seasons with cold areas in the north and south of the earth for the first time due to the lack of global temperature compensation.

The Jurassic is a geological period of the Mesozoic era in Earth's history. The Jurassic began about 201.3 million years ago and ended about 145 million years ago. It therefore lasted about 56.3 million years. The Jurassic rests on the Triassic and the Cretaceous. The Jurassic is named after the Jura mountains in the European Alps, where limestone strata of the time were first identified.

By the early Jurassic, the supercontinent Pangea had begun to split into two landmasses: Laurasia to the north and Gondwana to the south. During the early Jurassic, Pangea, located on the supercontinent, continued to disintegrate, which had already indicated the formation of trench systems in the Upper Triassic. Pangea broke out into Laurasia (North America, Europe) and into the south of the main continent, Gondwana.

The beginning of the Atlantic and the Tethys Sea were still narrow. Gondwana also began to break into the Upper Jurassic.

Dinosaurs evolved from reptiles during the Triassic and were to dominate Earth's ecosystems until the end of the Cretaceous. Birds evolved from the theropod group. Also, the first small mammals, flowering plants, and most of the trees we know today appeared.

The climate in the Jurassic was warm, no traces of large ice shields were found inland. As in the Triassic, there was no solid land near the geographical poles of the Jura.

Gymnosperms dominated the flora (including conifers such as redwoods and pines, but also ginkgos and cycads). The Jurassic is also called the age of cycads because they were very common. The undergrowth of the forests formed ferns and horsetails.

Evidence suggests that a meteorite struck near the Yucatán Peninsula (Mexico) in the late Mesozoic. This impact is often held responsible for the extinction of 50% of all animal and plant species - including all large vertebrates (including non-avian dinosaurs), many plant species and much of the fauna and flora. marine flora.

Characteristic invertebrates of this period were ammonites, spiral-shaped cephalopods and smaller belemnites with elongated, pointed inner faces, as well as echinoderms, brachiopods and crustaceans. Vertebrates, especially reptiles, were widely developed. Mammals, birds and angiosperms or flowering plants also appear at this time. However, the dinosaurs were not the only animals that flourished throughout this era, fish and other reptiles, such as turtles, for example Archelon, or crocodiles, some of which reached a large size, such as Sarcosuchus or Deinosuchus.

The Tertiary or Cenozoic era (from -65 to the present day or from -65 to 1.8 Ma) which is generally subdivided with a Quaternary era (-1.8 Ma to the present day)

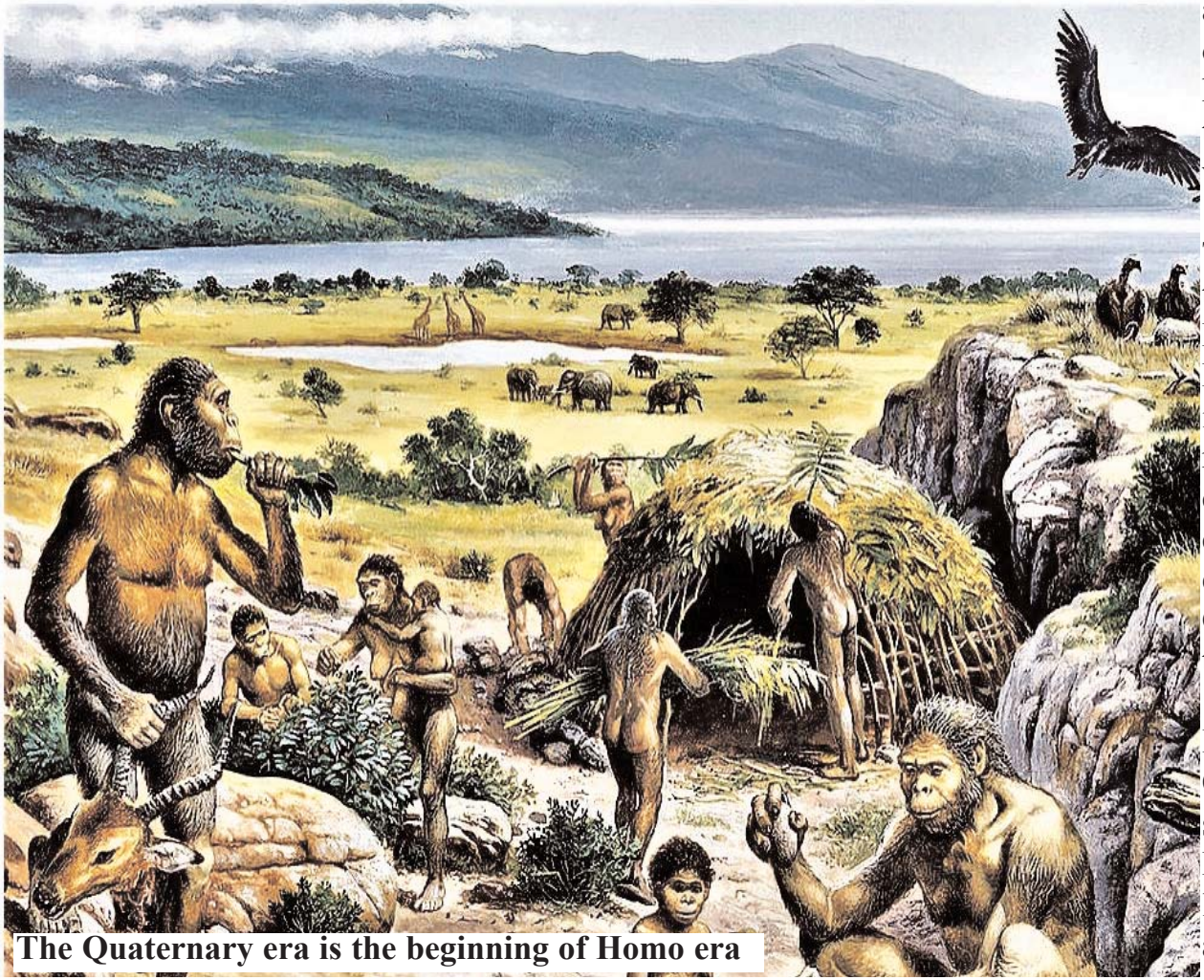
The Cenozoic era, or tertiary era, is the geological era extending from our days (we are still in this period) to -66 Ma. This division of the geological time scale belongs to the Phanerozoic eon; inland, the Cenozoic follows the Mesozoic. It began about 66 million years ago and extends to the present.

The name Cenozoic comes from the Greek language and means "new life". The Tertiary period, currently unrecognized by the International Commission on Stratigraphy, comprised the Cenozoic era, except for the past 2.5 million years, at the beginning of the Quaternary period.

During the Cenozoic era, India collided with Asia 55-45 million years ago, and Arabia collided with Eurasia, closing the Tethys Sea 55-45 million years ago. 35 million years old. As a result, the Great Alpine Fold that formed major mountain ranges in southern Europe and Asia, such as the Pyrenees, Alps, and Himalayas.

The Cenozoic is also called the age of mammals, animals which, when the dinosaurs disappeared at the end of the Cretaceous, underwent extraordinary adaptive radiation and became the characteristic fauna. About 30 million years ago, the first higher primates appeared (the most primitive were already present more than 65 million years ago), although Homo sapiens only appeared 200,000 years earlier. .

The Cenozoic was a period of long-term cooling. At the beginning of the era, particles ejected by the impact of the K/T boundary blocked solar radiation. After the tectonic creation of the Drake Passage, when Australia separated completely from Antarctica during the Oligocene, the climate cooled considerably due to the onset of the Antarctic Circumpolar Current which produced a great cooling of the Antarctic Ocean.



The Quaternary era is the beginning of Homo era

In the Miocene there was a slight warming due to the release of hydrates which release carbon dioxide. When South America joined North America in the creation of the Isthmus of Panama, the Arctic region cooled due to the strengthening of the Humboldt and the Gulf Stream, leading to the Last Glacial Maximum.

The Quaternary era characterizes the most recent geological era, posterior to the Tertiary with which it forms the Cenozoic. The Quaternary is the most recent of the three periods of the Cenozoic era in the ICS geological time scale. It follows the Neogene, spanning 2.588 ± 0.005 million years ago to the present day. The relatively short period is characterized by a series of glaciations, the appearance and expansion of anatomically modern humans, and assessing their impact on the natural world.

The Quaternary includes two geological epochs: the Pleistocene and the Holocene. The Quaternary is intended to cover the recent period of glaciation cycles and, since some cooling and glaciation episodes fall into the Gelasian, this justifies its transfer to the Quaternary.

It was during the Quaternary when Homo sapiens appeared on Earth. At the same time, large species, both plant and animal, have disappeared, and it is birds and mammals that are the vertebrates that dominate the Earth. In short, there was a great predominance of mammals, a great expansion of human beings, and the presence of flora and fauna very similar to

that of today, which also explains the migrations of large mammals or the origin of man. as possible criteria. This is why it is sometimes called the Anthropozoic stage.

During the maximum glaciers, the temperature in surface ocean waters was 4 to 5°C lower than it is now (currently it is 18°C for subtropical waters and 14°C for subpolar waters) in the tropics. During interglacial maximums, the temperature could be 1 to 2°C higher than the current temperature.

The presence of ice in much of the continents has greatly altered atmospheric circulation patterns. Winds near the ice margins were strong and persistent due to the abundance of cold, dense air from the glacier. These winds picked up and transported large amounts of fine-grained sediment eroded by the glaciers. This dust accumulated as loess, forming irregular deposits across much of the Missouri River Valley in central and northern China.

Sand dunes were much more extensive and active in many areas during the early Quaternary. A good example is the Nebraska Sand Hills region 19 which covers an area of approximately 60,000 km2. This region was a large field of active dunes during the Pleistocene, but today it is largely stabilized by pasture cover.

The Pleistocene climate could be characterized by the continuous El Niño phenomenon with trade winds in the South Pacific, weakening or warming in the east, warm air near Peru, warm ocean currents in the western Pacific and Indian Ocean in the east Pacific, and other El Niño markers.

During the ice ages, the rains were less abundant due to the decrease in the evaporation of water from the oceans. On the other hand, due to this dry climate, the deserts would be more extensive and drier. Until recently, it was thought that during the Quaternary, fluctuations in the total volume of ice on land, at sea level and in global temperature occurred in cycles of, initially, 41,000 years and, more recently, 100,000 years ago. For this, they were based on the ice cores extracted corresponding to the last 800,000 years and in the marine sediment cores for the previous periods.

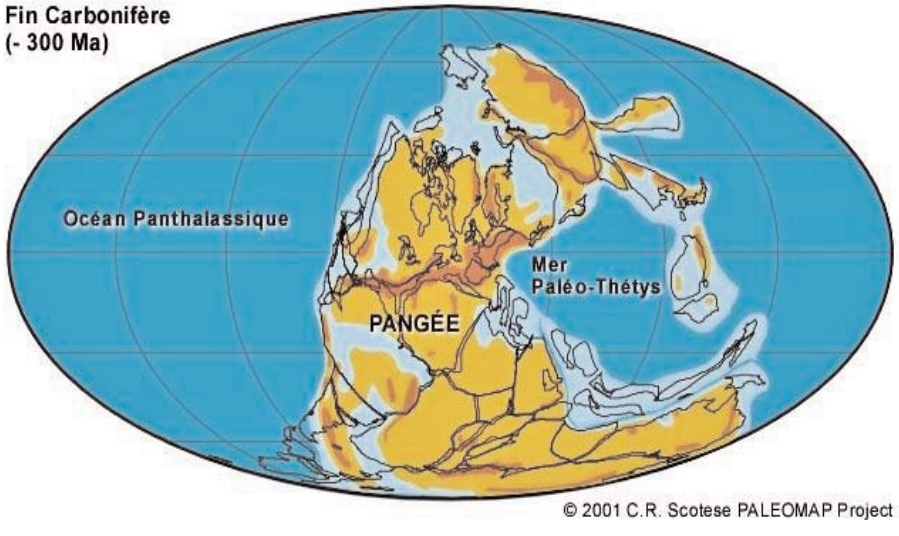
It is estimated that there have been about 80 cycles of glaciation. Thus, it has been assumed that in the last million years four major glaciations, with their consequent inter-periods, have been called (according to the classical school which takes as a reference Central Europe with the name of the rivers, tributaries of the Danube, where the first observations): Günz glaciation (beginning 1.1 million years ago), Mindel glaciation (580,000 years), glaciation of Riss (200000 years) and glaciation of würm (80000 years). Two previous episodes of glaciation were called Biber (2.5 million years) and Donau (1.8 million years).

The idea had been established that at the present time, at the end of the Würm or Wisconsin glaciation, the earth was in an interglacial period, which marked the beginning of the Holocene era. This would have started about 12,000 years ago, leading to the disappearance of the ice sheets of the last ice age. The remnants of this ice cap, which still exist in Greenland and Antarctica, now occupy about 10% of the Earth's surface. The glaciation cycle is still considered to be ongoing and some researchers believe the next ice age could occur within 50,000 years.

But today, the very definition of glaciations in the classic sense (long and stable cold episodes followed by other warmer ones) is called into question. It is currently assumed that there was a series of very short isotopic stages, which scientists refer to as even numbers for cold phases and odd numbers for temperate phases. Despite this, terminology related to glaciations continues to be used as a reference when dating the events of the Quaternary and its corresponding Paleolithic.

PANGEA

Over the past 3.5 billion years, several supercontinents have formed and broken apart, radically altering the history of our planet. More than a century ago, scientist Alfred Wegener proposed the notion of an ancient supercontinent, which he named Pangea. As proof, fossils, identical plants - some extinct - are also found on continents that today are very disparate. The same is true for mountain ranges: the Appalachians in the United States, and the Atlas Mountains in Morocco, were once part of the Central Pangea Mountains. They may have been formed by the collision of the supercontinents Gondwana and Laurussia. Near the equator, the (future) Pangea



begins its formation with the rapprochement of Gondwana and Laurussia. The Panthalassa Ocean covers the rest of the planet. A few minor oceans exist: Paleotethys, Prototethys, the Rheic Ocean, the Uralian Ocean closed by the collision of Siberia and Baltica.

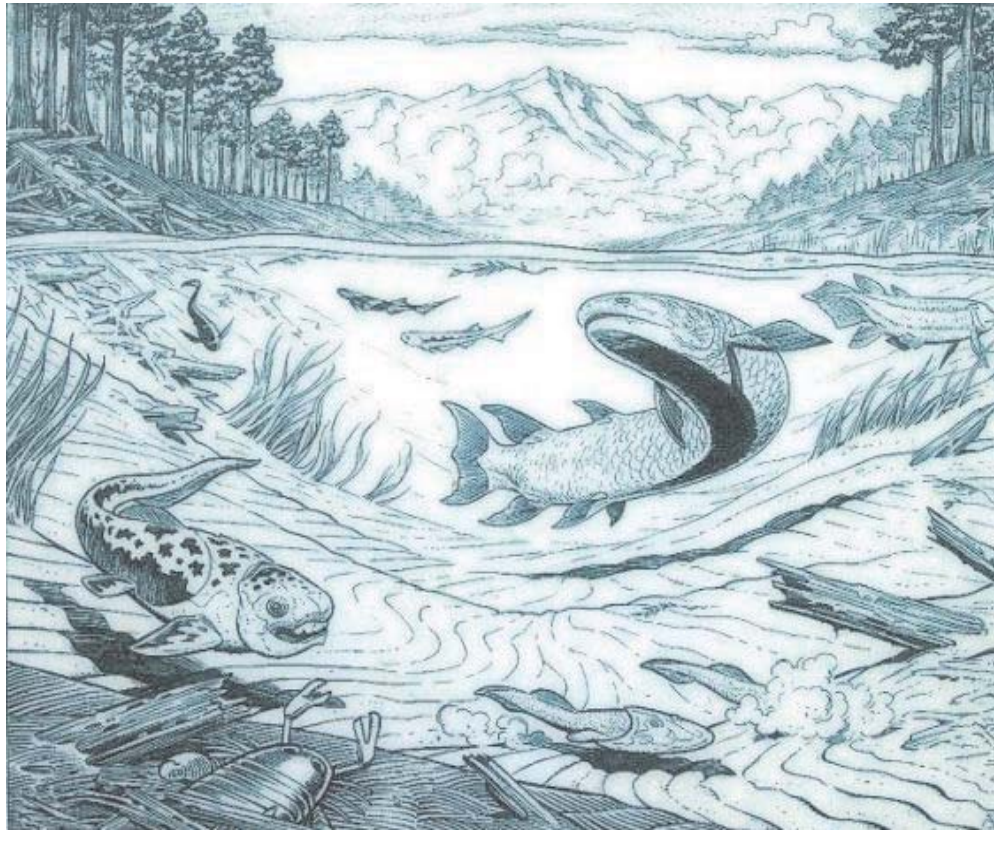
WILDLIFE

A major mass extinction, the Devonian extinction, takes place in the Upper Devonian, between the Frasnian and the Famennian, which affects up to 70% of living species. The cause of such extinction scale sounds, which later diversified. The first sharks appear at the beginning of the Devonian. Bone fish, some of large size, soon join them. During the Upper Devonian, our ancestors, the lobed fish evolved into the first tetrapods, such as the Tiktaalik roseae, which walked the land in the late Devonian. Ammonoidea appear in the late Devonian or at the end of the Silurian but only become abundant during the Mesozoic. The most evolved forms of graptolites disappear.

Comparable to Africa's Namib Desert and Australia's Lake Eyre basin, Pangea's climate - it seems - was generally arid with short, recurring wet periods that sometimes included huge floods.

TERRESTRIAL BIOTOPES

On land, Silurian bacteria and algae are joined during this period by primitive plants that created the first loams and hosted arthropods, such as moths and scorpions, and myriapods, arthropods were already present on land before the Devonian



The first fossil traces of insects date from the Late Devonian. At the end of the Devonian the first amphibians and arthropods are firmly established on earth. In the Upper Devonian forests of primitive plants exist: lycophytes, sphenophytes, ferns and progymnosperms appeared. Most of these plants have real roots and leaves. Ferns specied into giant tree-like forms. At the end of the Devonian the first seed plants appeared. The rapid appearance of so many different plant groups is known as the Devonian Explosion. Primitive arthropods co-evolve with these diverse plants. The evolutionary dependence between insects and seed plants is characteristic of the modern living world and has its roots in the Devonian.

To colonize dry land, you need to be able to reproduce there. How to do without the ocean? Plants and animals show an overflowing imagination. One does not so easily erase one's origins, especially when it comes to reproducing. A vestige of this mania that fish had for releasing their semen into the water, the first amphibians, after millions of years of terrestrial colonization, still return to the swamp, like current frogs, to mate and lay their eggs.

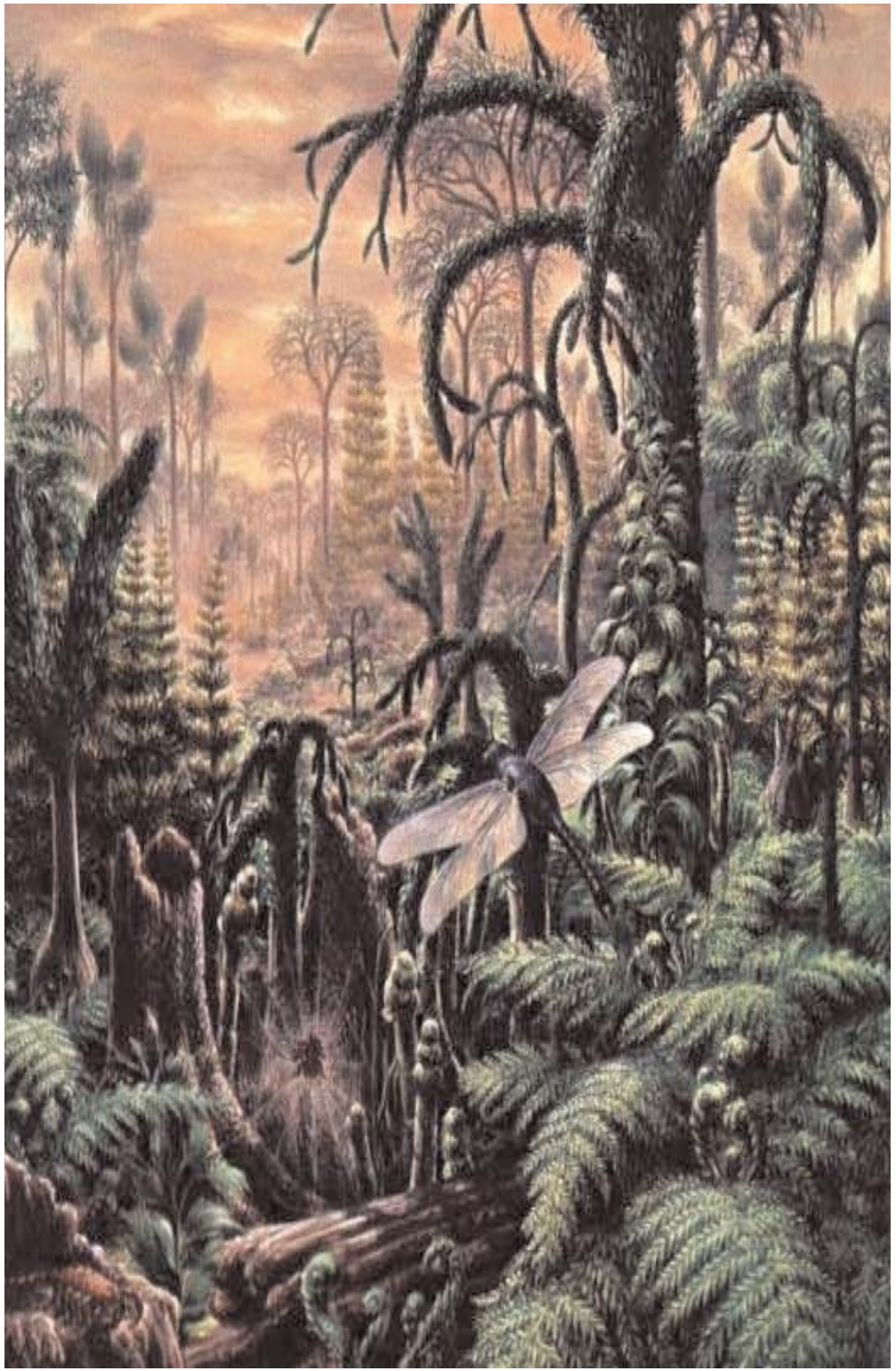
The other branch of the tetrapods - the amniotic vertebrates - which will later give rise to the famous dinosaurs, birds or mammals, follows a more daring path. To better free herself from the primordial ocean, she artificially recreates it. "These animals invented the egg that can be laid out of water", explains a little enigmatic Philippe Janvier, at the National Museum of Natural History. What does this original egg contain? A membrane filled with water, the amnion, which protects the embryo and allows it to develop in an aquatic environment. An innovation that mammals kept in the form of amniotic fluid and which allowed vertebrates to leave the shores for good to conquer higher and drier lands.

For the plants, exactly the same thing happened: a kind of internalization of the primordial ocean through what can be called the pollen chamber of the ovum.

Because like the amphibians, the first terrestrial plants remain strictly subservient, for their reproduction, to the aquatic environment. They are cryptogams, a vast group of plants without flowers, whose best known representative, the fern, still needs water today to reproduce; if only morning dew. Why? Because its antherozoids, equivalent to spermatozoa for plants, must swim in the external environment, thanks to their vibrating cilia, to the oosphere, or female gamete, which one of them will fertilize. that which took place millions of years earlier under the sea depths.

The appearance of the ovum will allow plants to free themselves from the primordial ocean by recreating it as the amniote vertebrates will do later.New ferns so-called ovule ferns which will thrive for a few tens of millions of years before dying out, begin to produce new female spores which germinate to form a closed organ - the ovum - in which the oospheres will develop. , they are pollen grains released by the wind. Those that manage to attach themselves to the ovum release antherozoids, which will have to swim in the drop of water bathing the pollen chamber, to meet the oosphere. A simple droplet as an ocean.

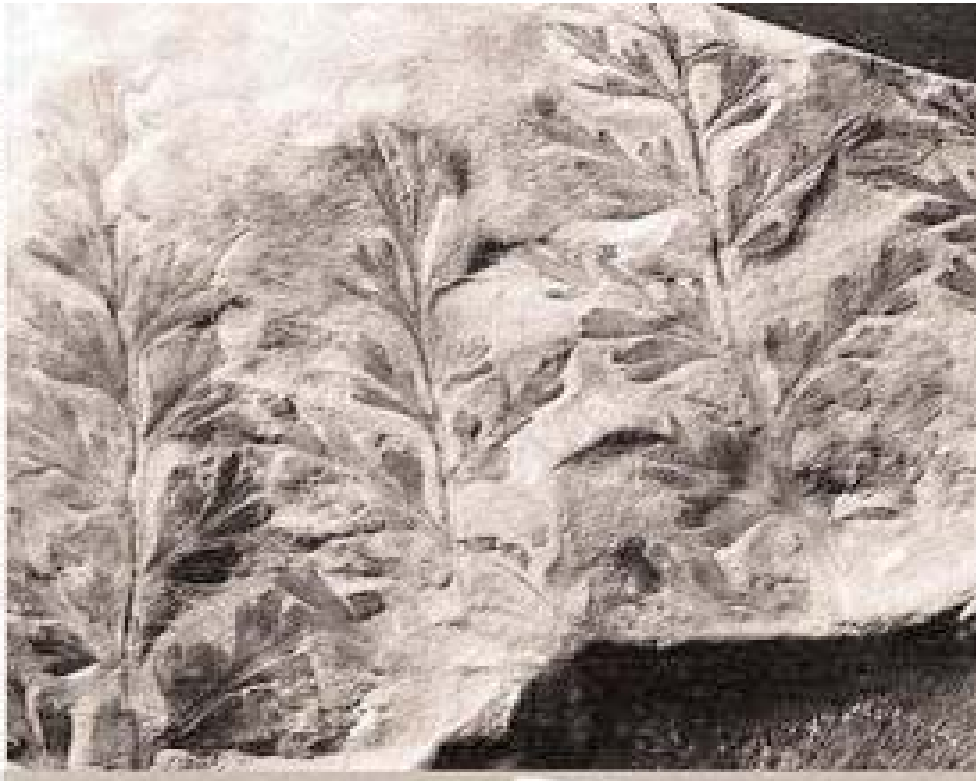
We have to wait for the phanerogams, 300 million years ago, to see terrestrial plants definitively cut ties with their aquatic origins. In these plants that appeared in the Carboniferous - and which ended up protecting the embryo in this veritable safe that is the seed - the male reproductive nucleus no longer needs to swim. Nor even, moreover, to move by itself: it is delivered "turnkey" by a pollen tube which makes its way into the tissues of the female organ. For the first time in the history of life, an organism can reproduce in a completely dry environment. Animals are always unable to do so. These phanerogams will then perfect the process by protecting the seeds in a fruit, like the pips of an apple. A refinement that will make these phanerogams called angiosperms, the undisputed masters of terrestrial flora.

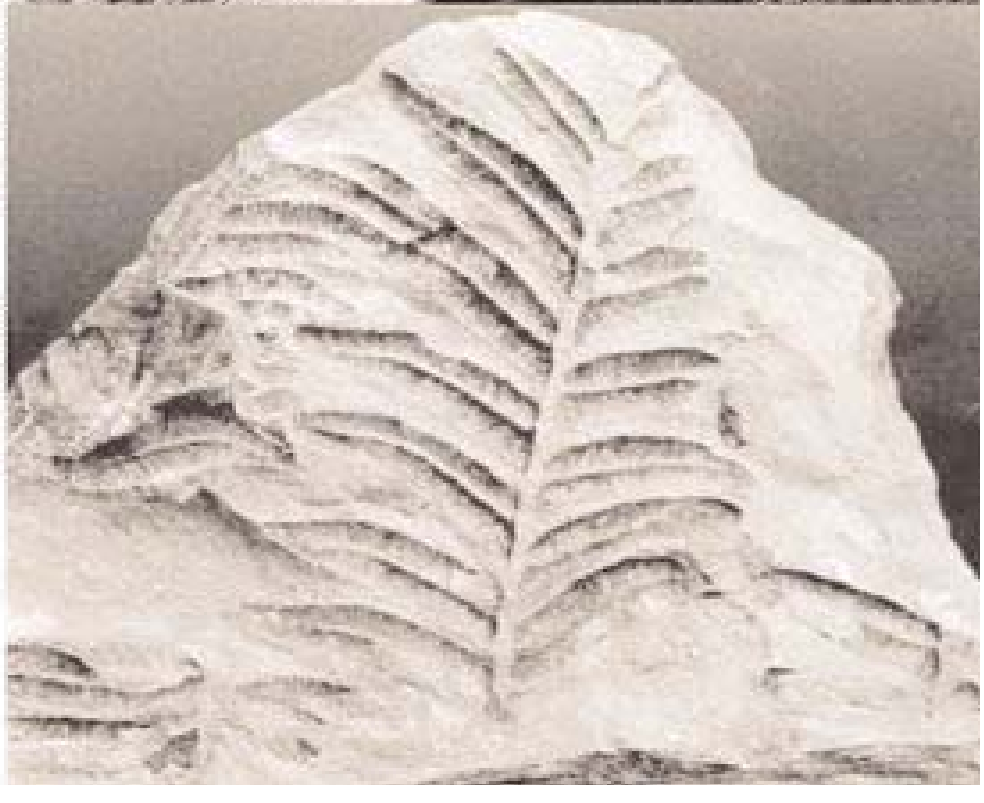


JOGGINS CLIFF - NOVA SCOTIA - CANADA

About 300 million years ago, the present eastern shore of Chignecto Bay, north of the Bay of Fundy, was a tropical rainforest near the equator. Known as the 'Galápagos of the Coal Age', the Joggins Fossil Cliffs provide a remarkable example of the evolution of life on Earth during the period known as the Pennsylvanian Period of Earth's history. paleontology has been recognized since the middle of the 19th century, when Sir Charles Lyell declared that the "fossil coal-tree forest" exposed in the sea-side cliffs was "the most marvelous phenomenon I have ever seen." Born in Scotland, Lyell is the father of modern geology. His examination of this fossil forest resolved the then hotly debated theory of the origin of coal, confirming that it was formed in situ from decaying material from ancient forests. These 300-million-year-old trees were mostly lycopods, or scale trees, so called because of the shape of their bark. Ancestors of today's club mosses, these Coal Age (Carboniferous) giants stood up to 30 meters high.

Lyell was accompanied by a young Nova Scotian, William Dawson, who later became Sir William and the most eminent Canadian geologist of the 19th century. In 1852, Lyell and Dawson discovered, in a fossilized tree stump, the remains of the oldest known reptile among fossils. A century and a half later, this lizard-sized animal called the Hylonomus lyelli, or "dweller of the forest", still remains the oldest truly terrestrial creature ever found. She was apparently trapped in a hollow tree stump, where she was preserved when sludge from a meandering river system washed away in what Dawson calls a "weird deposit." The site contains the most important remains in the world of the two characteristic elements of the "Coal Age": the terrestrial tetrapods, in particular the first reptiles and the first amniotes, and the "Carboniferous moist forests" which served as their habitat. The appearance of amniotes, the first vertebrates to acquire the ability to reproduce out of water, was one of the most significant events in the history of life on Earth.





The first forms of life, probably bacteria, appeared nearly 3.5 billion years ago. 97% of all our atoms are of stellar origin, therefore extra-terrestrial. 600 million years ago flat-bodied organisms, algae and plant mosses appear. Then marine invertebrates, which thanks to the intergalactic calcium produced by supernova explosions whose cosmic clouds reach the Earth, begin to mutate towards vertebrates: crustaceans and fish. Without calcium, no bones and teeth, no skeletons, no vertebrates.

BURGESS SHALE

Discovered in 1909 by paleontologist Charles Doolittle Walcott, the Burgess Shale is sedimentary rock formed from particles of clay and silt deposited along a reef about 505 million years ago, i.e. say just after the famous Cambrian explosion. The shale layer is embedded in a wall of the Rocky Mountains in Yoho National Park, on the western slope of Mount Stephen in Canada.

These shales have become famous because they contain extraordinarily well-preserved fossils of animals that lived at that time and which today seem very strange to us. These fossils are particularly remarkable because we see the imprints of the soft parts of animals of the time, and in 3D, which is extremely rare. Charles Walcott initially asserted that the organisms of the Burgess fauna belonged to extinct categories, within groups of animals still existing today. However, many of these animals seem rather bizarre to us, and subsequent detailed descriptions of them have highlighted the difficulty of applying modern group definitions to them.

Some, especially Stephen Jay Gould, have seen it as proof that the Cambrian Explosion was a time of experimentation, since organisms at that time had many more organizational plans than they do today. (and thus testified to a greater evolutionary disparity). Chance has made that only some of these organizational plans have survived, constituting the branches that we know today. If Gould was right, and if the bizarre creatures of the Burgess Shale - which he called "strange wonders" - do indeed represent extinct offshoots, the Cambrian Explosion was a time of evolutionary innovation on a far greater scale than we never suspected before.

The researchers analyzed the shales millimeter by millimeter and concluded that these sedimentary rocks were not formed slowly but following a series of sudden mudslides quickly burying the animals that lived at the base of the reef. The mud seeped into the organs and thanks to thin layers of sediment, they separated from the body in different micro-levels. This is why a certain three-dimensional structure was retained, even during strong compression of the sludge. Moreover, by abruptly isolating the soft parts from the oxygen contained in the water, this rapid burial slowed down their decomposition. This is why, today, scientists can study there at leisure more than 65,000 specimens belonging to 120 species.

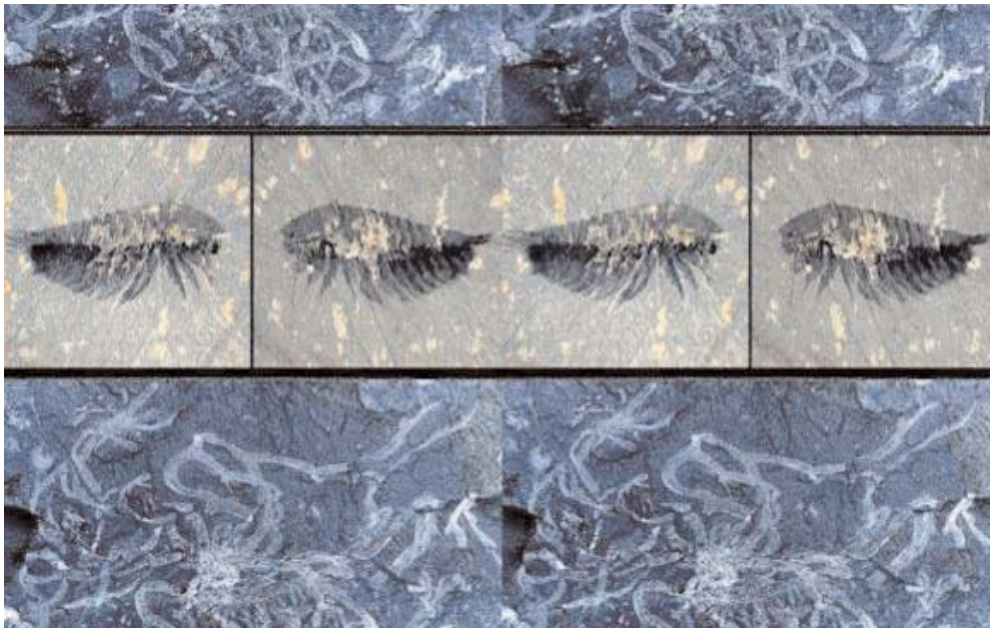
The Burgess Shale provides direct fossil evidence for the appearance of a series of animal groups in mostly unoccupied marine environments prior to the Cambrian Explosion. This evolutionary radiation occurred at the same time as a sudden intensification of the complexity of ecosystems, marked by the occurrence of new types of interactions between species resulting from ecological innovations - such as new modes of feeding and locomotion.

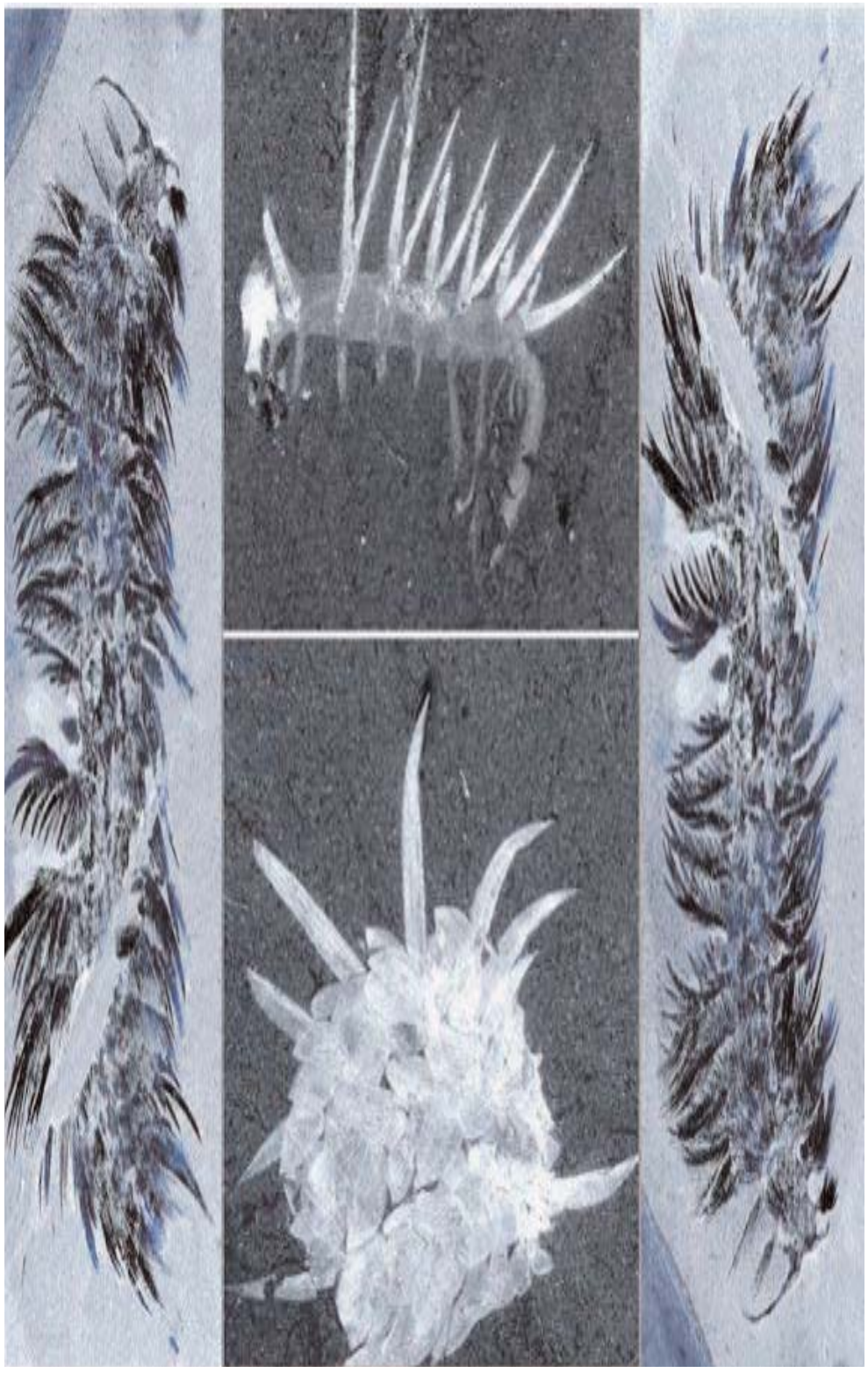
The explanation for the Cambrian Explosion may not lie in the environment or regulatory genes, but in the complex ecological interactions between animals. The explosion may have been the result of co-evolution, with the various inhabitants of the Cambrian ecosystem having been 'pushed' to evolve by changes in this ecosystem.

laissant subsister que les ancêtres des embranchements actuels. À la fin de l'explosion cambrienne, les structures écologiques fondamentales des écosystèmes marins modernes étaient fermement implantées.

For example, the appearance of predators might have stimulated skeletal evolution (including mineralized plates) for protection or, in the case of swimming, as a means of escape. Before predation spread, different "experiments" of organizational plans could have occurred, in a context of interactions between species probably still quite limited. Settlement in hitherto unexploited environments was to allow the survival of even poorly adapted organisms, perhaps endowed with one of the curious organizational plans observed in the Cambrian. The interaction of organisms with the environment has undoubtedly created new ecological niches (particular places occupied by species in an ecosystem).

We can think of the appearance of zooplankton, bringing organic matter to benthic organisms, or that of burrowing, which made possible new interactions with sediments. But, after tens of millions of years, the multiplication of organisms occupying these niches has led to competition which has eliminated those with less well-adapted organizational plans, leaving only the ancestors of the current branches to remain. By the end of the Cambrian Explosion, the fundamental ecological structures of modern marine ecosystems were firmly established.





Miguasha

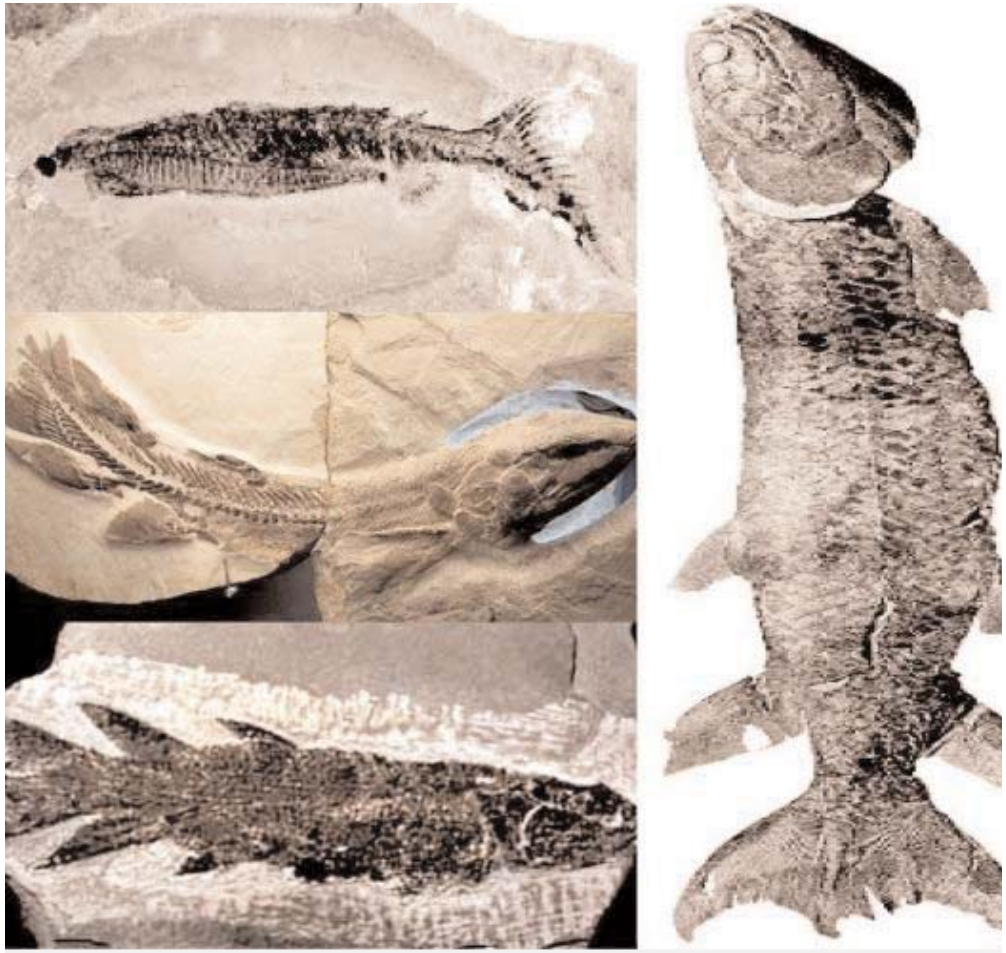
The Micmacs of Gaspésie called the sector Megouasag: red cliff. Having become Miguasha over time, the place is still as red as ever. At the western end of Baie-des-Chaleurs, on the north side of the Restigouche River, Miguasha owes its red coloring to the Bonaventure geological formation. But the place owes its fame rather to the formation which is just below, at the level of the beach. For 125 years, the Escuminac Formation has been famous among paleontologists around the world. And for good reason: it has delivered thousands of surprisingly well-preserved fossils, mainly fish that lived in the Devonian, 380 million years ago.

Around 360 million years ago, the eusthenopteron foordi, the famous fossil fish discovered around 1960 in Miguasha in Gaspésie in Quebec, possessing terrestrial respiration and being able to crawl, undertakes the difficult and perilous exit from the water and finds itself in an environment totally different where ferns, among others, reach more than 30 meters in height. During this Upper Devonian period, Miguasha was a huge freshwater lake with little oxygen and low in bacteria, which would have facilitated the fossilization of species.

Continental drift has only just begun. All the continents are united in a compact mass under the Equator. Comparisons between the specimens found at Miguasha and those from Scotland, Greenland, northern Germany and Russia indicate that these fossils are the first biological evidence showing that the continents were joined together at that time and had a climate of tropical type. Is this the Earth, this planet with unrecognizable continents, whose northern hemisphere is covered with an endless ocean? The six continents that we know, the two great oceans, all that does not yet exist. And the climate seems warmer than today...there is no ice at the North Pole! Even the days don't have the same length! This unique continent, Pangea, did not subsequently break up. Welcome to the Upper Devonian. For this visit to the Earth 380 million years ago, you have to forget what you are used to seeing on our planet and put yourself in the shoes of a space traveler who arrives on a new planet. The change of scenery is indeed rather complete.

A look at living species is also puzzling. If the tropical regions are in places covered with forests, the trees they contain are not very diversified. On the ground, on the other hand, small non-woody plants present a greater variety. And you have to be very attentive to see animals. Hidden in the litter of the ground, a few invertebrates survive.

But in the water, it's an other story. The invertebrates are of course numerous, but the fish are also abundant and varied. But they look funny and few of them resemble today's species. Rightly, the Devonian has been nicknamed the Age of Pisces, in reference to the evolutionary proliferation that they operated during this period.



We now find descendants of "Lipneuste", another fish with lungs and able to crawl, in Australia, Africa and South America.

Even more incredible, in addition to breathing, our first ancestor moves by relying on articulated bones (our current limbs, legs and forearms). This scientific discovery leads us to a whole philosophical questioning: We are indeed descended from fish.

Yes, man is a descendant of fish and evolution for several other million years became more complex: amphibians, dinosaurs, birds, primates (50 million years) and finally the arboreal Australopithecus (5 million years) our primate ancestor followed by Homo erectus (one million years) and Neanderthals (300,000 years) and finally Homo sapiens, our 40,000 year old immediate ancestor.

Thus emerges an unavoidable constant, the purpose of life is to increase the Consciousness of the living and each cell continuously exchanges information with its environment to increase its "memory points". The construction of the human brain whose 1013 neurons once deployed in the cerebral connective are connected by 1015 synapses constitutes a performance that defies all imagination. Following the Broglian theorem, it goes without saying that henceforth, creation and evolution go hand in hand.

Creation and evolution then appear as two infinities: the Universe as infinite magnitude and the nature of our terrestrial world as infinity of possible temporal forms and diversity of living beings. Two seemingly contradictory universes yet united within a single totality: "vital momentum" and "creative evolution" forming a Whole itself in "continuous creation of unpredictable novelties" as the philosopher Bergson writes in Creative evolution.

Miguasha's fauna is one of the most representative of the Devonian. It is recognized as a window on the phylum of the vertebrates during the Age of Pisces, but it also testifies to the phylum of the invertebrates in the aquatic and terrestrial domains, at this pivotal time when the animal kingdom left the aquatic environment to make the conquest of the emerged continents. Since the first recorded excavations, in the summer of 1879, more than 17,000 specimens of vertebrates, invertebrates and plants have been extracted from the cliff. Of this number, approximately 10,000 specimens are part of the collection of the Natural History Museum

The rest is dispersed in the collections of some thirty research centres, museums and universities in Canada and in several countries around the world. This fauna includes about twenty species of fish that are essentially endemic, that is to say, they are not found in other regions of the globe. These species bear witness to different stages of vertebrate evolution and they belong to different groups, many of which are now extinct. They include some of the most primitive as well as some of the most specialized and perfected forms in the evolutionary history of fish. A whole panoply of forms rub shoulders. With large carnivores with powerful bodies and sharp teeth, small bottom-dwelling fish filtering the mud to unearth their subsistence, fast small fish with spines living in schools, the ecosystem has as many predators as prey.

At the foot of the newly formed Appalachians, a wide estuary extends and serves as a link between a river which has its sources in the mountains, and the sea which extends further. The water is rather low in oxygen, so having lungs seems to be the norm in many species of fish. The oxygen that they can't get through their gills, they will draw from the air in a few puffs. So much so that some Miguasha species were possibly adept at surviving out of the water for a short time, and perhaps even crawling along the shore using their strong fins to get back into the water. Proof that man descends not only from monkeys but also from fish. Together, these aquatic and terrestrial vertebrates and invertebrates were an integral part of an ecosystem that has now disappeared but whose traces are sufficiently abundant and detailed for it to be possible to reconstruct it with precision. In terms of numbers, the placoderm Bothriolepis canadensis is the most numerous species. At the Natural History Museum, this species accounts for 28% of the 10,000 specimens in the national collection, a veritable sanctuary for Bothriolepis! Even a cult fish like Eusthenopteron was represented by 1600 specimens in 2006. And we counted up to 600 specimens per square meter of the small acanthodian Triazeugacanthus affinis on the surface of certain layers! That is to say the very high concentration of fossils found in Miguasha. Such a site is a "quasi-renewable" asset, since only a small fraction of the formation has been excavated and new outcrops have been identified inland in recent years. What does excavation have in store for us over the next few years?

nFor several billion years, the living will make increasingly complex leaps to diversify: the passage from the unicellular to the binary, passage from the invertebrate to the vertebrates, amphibians, dinosaurs, birds, primates and finally Australopithecus arboreal, our ancestor.

We owe our existence to our perception of colors. It is an integral part of the functions set in motion by evolution to guarantee our survival. Our field of vision has been between 400-800 nanometers for millions of years, since the era of our arboreal Australopithecus ancestors. Why do we see the colors specific to this field? Indeed some animals see infrared, beyond 800 nanometers, others ultraviolet, below 400, not us. Insects, mainly butterflies, recognize a wide range of colors while nocturnal animals including a large part of mammals and diurnal herbivores distinguish a limited range. Only primates and hominids are exceptions, they are frugivorous and, like butterflies, must perceive a wide range of colors and shapes that correspond to the fruits they need to consume to live and those they must reject because dangerous or toxic to their health. We therefore perceive colors and shapes according to our strategy of exploitation of natural resources which ensures our survival. Moreover, we "color" the other animals and plants of creation according to their usefulness or not, of their dangerousness or not, not to mention the use of the dazzling ornaments between animals of the same species for breeding purposes. The colors perceived by hominids have a crucial significance for their very existence. :

The chlorophyll that we see green, absorbs blue and red radiation. This means that the photosynthesis at the base of all life on earth takes place in a window that corresponds exactly to that of the visual possibilities of animals. Color is essentially organized light that is only perceptible to organized beings.

MOTHER EARTH

It is the era of wandering; wandering of the primordial Australopithecus from 7 to 2 million years ago. For millennia, Australopithecus was essentially a vegetarian and would experience a wandering of gathering, moving from place to place in search of necessary food. This activity was essentially individualistic, each being responsible for his survival. We can speak here of a relative peaceful coexistence between hominid groups in a totally cruel world. The aggressiveness was essentially defensive in nature. (Chatwin) It's about imagining our arboreal ancestor living in an environment of carnivorous predators, to understand that he is regularly attacked and that all his vegetarian aggression is directed towards defense for his survival. We also think of the defensive aggressiveness of the mother protecting her offspring.

It is the era of matriarchy centered around the female, because not only does she give life but above all, she protects it, she is the guarantee of the evolution of the species. This matriarchal era will last almost 5 million years, a duration several times greater than that of the patriarchy which dates from around 2 million years ago until today. The matriarchal diet is essentially based on vegetarianism (gathering) while that of the patriarchy is mainly based on meat (hunting). The female will always be associated with the plant world, with nourishing earth, with agriculture, with the fertility of life.

Periods of overpopulation in groups of vegetarian Australopithecines set in motion mechanisms of regularization, the main one being the social exclusion of fasting males, by the alpha male, classified as supernumerary and forced to live at the limits of the territory claimed by the group. These "superfluous" do not have access to the food resources of the group, nor access to females for mating. Non-reproductive, the superfluous, often solitary, deprived of the protection of the group, suffer cruelly from the threats of the outside world and are more exposed to falling prey to ferocious carnivorous predators. Also excluded from nourishing territories where resources abound, they often face scarcity so that they must regularly travel long distances to satisfy their needs.

"The path is made by walking"

Since they can no longer count on the group to help and support them, they are condemned to form a new community with the other excluded groups capable of meeting their needs. Because they are young, these superfluous are more apt to experiment with new behaviors and often have the leisure to observe the behavior of predators in order to better protect themselves against them.

Overall, they discover not only new behaviors but also new foods. In times of famine, they do not hesitate to taste the carcasses of animals abandoned by predators. At first accidental, these behaviors gradually become habitual: looting the birds' nests to steal the eggs or devour the chicks, eating the placenta and naturally aborted fetuses, consuming nascent animal fasts. Thus is set up a replacement diet that will quickly become complementary to the initial vegetarianism.

When major climatic changes such as glaciations loom on the horizon, disturbances occur with them that upset the entire ecosystem of flora and fauna: the strict predators die from the scarcity of animals, thestrict vegetarians die of the shortage of plants and fruits, only the superfluous, both carnivores and vegetarians, have been able to adapt to the new environmental conditions. The excluded have become the dominators of a new existential paradigm, they form communities "of the future" and adopt behaviors such as direct action of group predation, the ancestor of hunting.

Thus, everything happened as if the mechanisms of exclusion had "programmed" the transforming mechanisms which allowed the birth of hominids. In short, the marginalized have saved our species from natural extinction by offering it a better ecological balance which has increased our autonomy vis-à-vis the surrounding natural environment.

Of the different families of Australopithecus, only the line of Australopithecus africanus and its descendants such as Homo habilis, Homo erectus, Neanderthal Man and finally Homo sapiens also called Cro-Magnon integrate meat into their menu; becoming omnivorous. The integration of meat into their diet is of paramount importance in the history of evolution and marks the beginnings of hunting after a long period of carrion including cannibalism. Indeed, only the lineage of the omnivorous Australopithecus (Homo habilis) will survive; strict vegetarians will disappear, unable to compensate for the harmful effects of the periods of glaciation on the plants which nourished them; weakened, they become easy prey for carnivores. Homo habilis also owes its survival to a major anatomical change: the lengthening of the legs which allows it to eventually reach the upright position, thus freeing the hands for other occupations. Its only code of "conduct" is nature, it is the language of nature where everything is played out at the level of instincts and innate behaviors. From vegetarian to omnivorous therefore also carnivorous, he adapts his behavior to his new diet and adopts hunting as another means of subsistence.

For the first time, perhaps, an activity (hunting) requires the cooperation of the members of the group with a view to a specific objective and association in the sharing of the game killed. Thus will be born the concept of group, tribe or if one prefers the sociability necessary for the attack but also for the defense against the other predators.

The arrival of meat in the diet introduces into behavior the offensive aggressiveness necessary for attacking game (predation) which complements the defensive aggressiveness of arboreal vegetarians. From now on, the development of aggressiveness in Australopithecus will follow the rules of hunting. We are thus witnessing for the first time a division of tasks: the defensive maternal aggressiveness will serve mainly to protect the camp and the newborns and to pick berries, nuts, tubers and fruits while the predatory male will hunt; although the female may sometimes participate in the predation effort by hunting small game around the base camp. (here there is no sexism, the aggressiveness of the female being identical to that of the male in intensity at least)

But before getting there, a whole evolutionary process, spread over hundreds of thousands of years, had to take place, such as the transition to standing which facilitates running, the creation of tools through the development of a brain also capable of memorizing abstract concepts necessary for (hunting) planning and their transmission by a rudimentary mode of communication, in short, the emergence of the mind by which it can act in a predictable way on the environment and sense the forces that govern nature, the cosmos and the emergence of fundamental archetypes as hieroglyphs of the unconscious.

With hunting, the Australopithecus' brain doubles in size, not overnight, but spread over a few hundred thousand, even millions of years. (At that time, we took the time necessary to do things well). Patiently, the Australopithecus, disadvantaged by nature, will create, from bones (knives, club) and branches (assegai), the weapons necessary for its survival. Without weapons, it's a safe bet that we wouldn't exist. Because the hordes of prehistory live in a world of terror and merciless cruelty where death was unthought, it happened suddenly, "killing to live" period. Australopithecus was scared, yes! by instinct but the fear of dying did not exist.

"With Australopithecus (Homo Habilis), between 3 million and 1 million years ago, the first tools appeared, traces of a technical behavior, external to the anatomy. The reproduction of the same gestures organized in logical and effective sequences proves the existence of the first concepts. The handling and use of these tools formed a motor for the sequence of ideas. There are remains of hunting and gathering showing the observation and prediction of animal behavior. In particular shelters developed indicate the existence of a meeting place, a protected place where young people could be educated and women fed by hunters.

This implies the existence of a prolonged learning process compared to other primates, therefore an educational mode allowing the transmission of an acquired social behavior.The elements at the origins of the first metaphysical experiences were therefore present: the emergence of consciousness leading to creativity on (revelation) of its equivalent in the sacred (unconscious) domain inaccessible by reason". (Bernard G. Campbell ed., Humankind emerging, 4th ed., Boston-Toronto, 1983, p. 228)

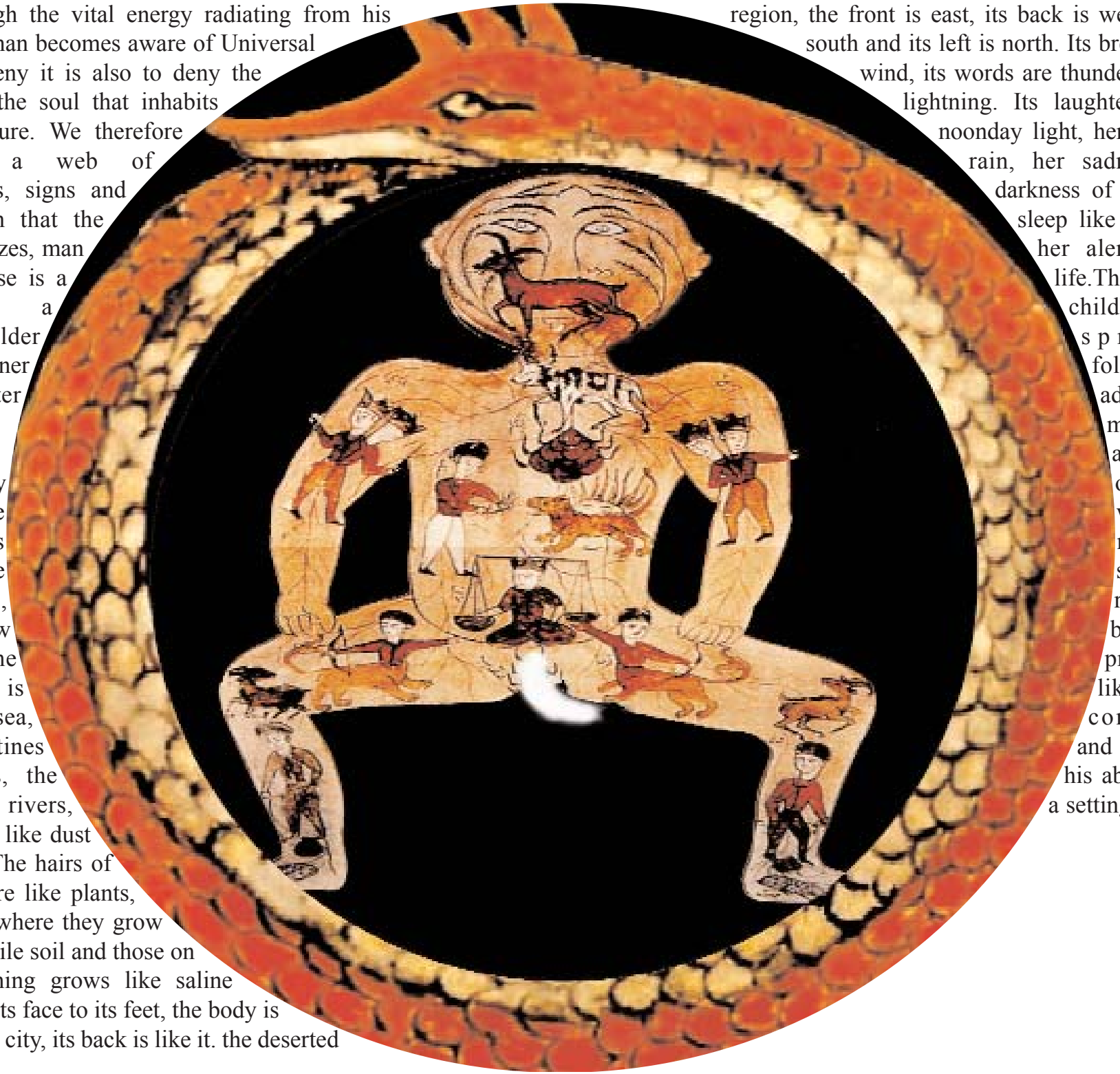
So much so that the tool is inseparable from the sacred. Not only does it ensure the survival and development of the species, but it produces a whole universe of mythico-religious relations, if only the mastery of distance by the throwing of the assegai, which nourishes the creative imagination. The anthropologist-economist Marshall Sahlins (1972) estimates that "the hunter-gatherer could amass what was required to live (food, shelter, medicinal plants, tools) after fifteen hours of effort per week; thus the rest of his time he used it freely for play and rest. Such was the original affluent society." Our ancestor therefore had time to play but also to concentrate and reflect on his condition and above all to experiment. Knowledge of hunting techniques leads Homo Erectus to conquer new territories by following the migration of animals. Leaving his alma mater; Africa (terrestrial paradise), Homo érectus undertakes a long period of wandering (wandering of Gilgamesh, Adam and Eve) which will lead him to a conquest, an immense expansion of his territory towards Asia as far as China and Russia, to Europe to Spain. Thanks to this prodigious expansion, the human species acquires a fabulous wealth of knowledge and adaptation to different environments, both climatic and food. This new knowledge disseminated in space corresponds to the foundations of current populations; the human species is divided into racial branches (anatomical modifications) and develops cultural specificities inherent in frequenting new territories. (food, habitats, etc.).

Remember, the more life evolves, the more the living becomes diversified. It will be the same with the territory. We will speak of territoriality, of cultural territory linked to a specific group: Caucasian linked to the particular conditions of south-eastern Russia, Negroid south of the Sahara in Africa and Mongoloid in the steppes of Central Asia; Native Americans are related to the Mongoloid group at the beginning and will acquire more and more specific characters.

The transition from archaic man from prehistory to ancient man therefore took place over several centuries. From this long evolution was born a whole panoply of concepts going from the economic exchange to the social organization while passing by a primitive technique centered mainly on the use of water, fire, earth. Quietly was born the experience of civilization based on a conscious choice of the individual towards collective life governed by laws and rules. A whole series of spiritual concepts followed the same evolutionary path ranging from dream, magic, totemic animism to the gods. The world was teeming with Gods, themselves also specialized: God of hunting, agriculture, war, forest, rain etc. Thus the astrological aspect, a more intuitive approach, close to myth and tradition also experienced considerable growth. While Vedic and Buddhist thinkers emphasized the body/soul-cosmos/spirit relationship, Arab philosophers undertook to establish the correspondences between the body, the heavens and nature. The stars and the stars are part of the familiar universe of man. Unable to physically reach the cosmos, man symbolically projects himself there to extend the territory of his kingdom. The sky is peopled with human and animal appearances. The constellations of stars become signs of the zodiac with its bestiary of bull, ram, fish, lion, scorpion and weave a network of correspondences with the human body divided into twelve parts linked to the astrological signs. Each limb and organ finds its counterpart in the heavens. Thus the ram governs the head and the face of man, bull, the neck, the throat; Gemini, shoulders, arms, hands; Cancer, chest, ribs and lungs; lion, stomach, heart, and back; Virgin, belly and entrails; Balance, the lower belly under the hips, the groins, the navel; Scorpio, the sexual organs, the bladder, the uterus; Sagittarius, the thighs; Capricorn, the knees; Aquarius, the legs to the heels and finally, Pisces, the feet.

It is through the vital energy radiating from his body that man becomes aware of Universal Life. To deny it is also to deny the spirit and the soul that inhabits earthly nature. We therefore live in a web of theophanies, signs and information that the mind analyzes, man in this sense is a pontifex, a bridge builder between inner and outer reality.

"The body is like the earth, its bones are mountains, its marrow mines, the abdomen is like the sea, the intestines like rivers, the veins are rivers, the flesh is like dust and mud. The hairs of the body are like plants, the places where they grow are like fertile soil and those on which nothing grows like saline soil. From its face to its feet, the body is a populated city, its back is like it. the deserted region, the front is east, its back is west, its right is south and its left is north. Its breath is like the wind, its words are thunder, its cries are lightning. Its laughter is like the noonday light, her weeping like rain, her sadness like the darkness of night and her sleep like death, just as her alertness is like life.The days of her childhood are springtime, follows the its adolescence, its maturity is its autumn, and old age is like winter. motions of stars and their rotations. His birth and his presence are like emerging constellations, and his death and his absence are like a setting sun."



Origin of man

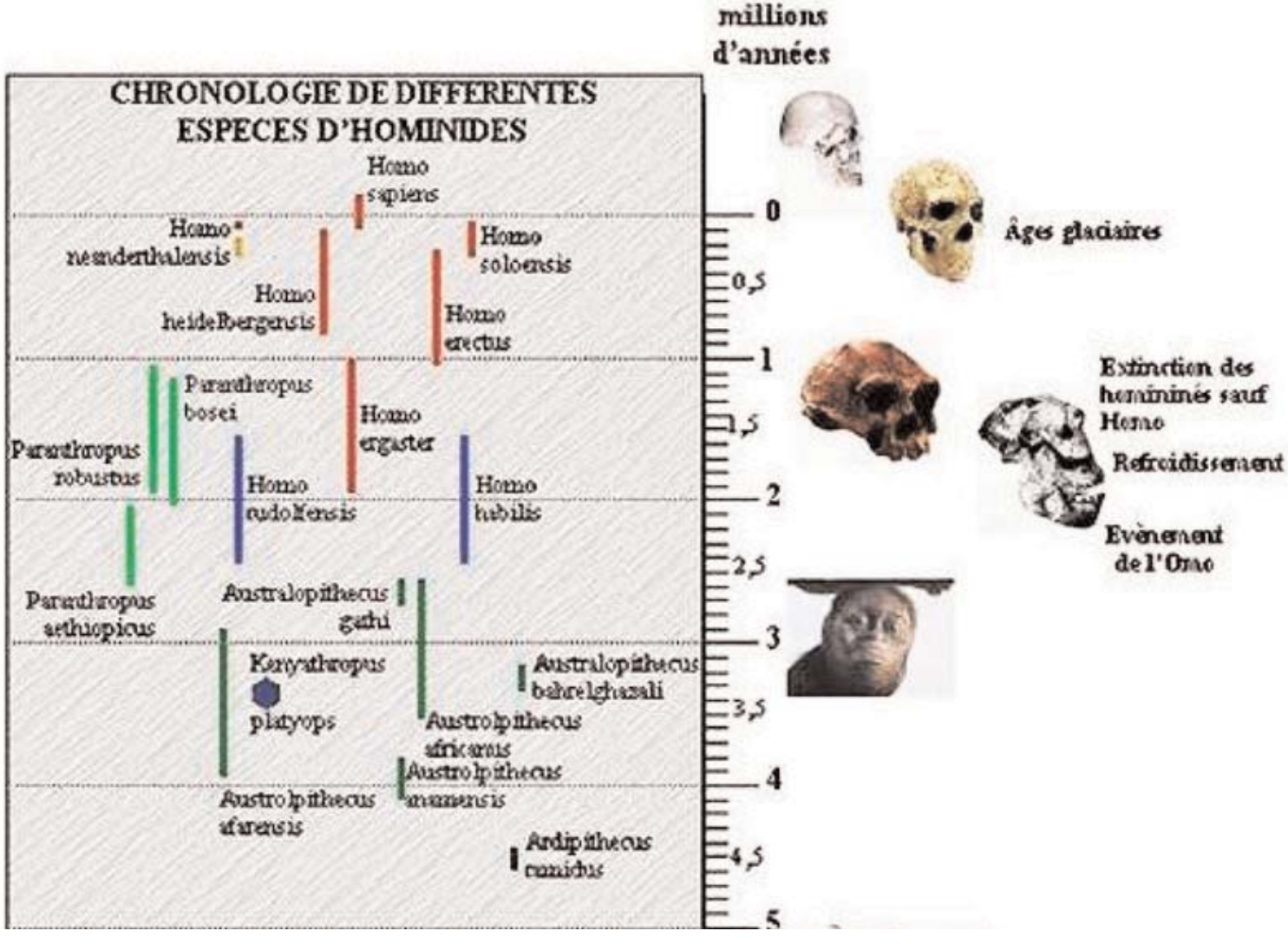
Homo habilis, our oldest identified ancestor (3 million years), is located in the African cradle. Homo erectus who first migrated from Africa to Asia two million years ago... then a second time to Europe a million years later. From -500,000 all the fossils found in Africa confirm that Homo erectus evolves towards modern man. 100,000 years ago, in Asia and the Middle East, we find this type of evolution towards Homo sapiens. In Europe, around -40,000 appears Cro-Magnon. All these fossils are unanimous... and dating methods confirm it.

The main stages of hominization

For Teilhard de Chardin "hominization is the set of evolutionary processes by which humans have acquired the characteristics that distinguish them from other primates".

* The evolution of the genus Homo is marked by:

* bipedalism is the first stage of acquired hominization in Australopithecines.



Other steps are gradually being put in place:

* the increase in brain volume goes from 300-400 cm3 in Australopithecines to about 1,400 cm3 in modern humans, but ... Homo sapiens neanderthalensis had a higher cranial volume of around 1,600 cm3. The comparison of the skulls and the endocranial casts shows an increase in the cranial volume and an increasingly important vascularization.

* language requires the presence of a vocal apparatus and the development of certain cerebral areas (Broca's areas).

Thanks to endocranial casts and basic studies of the skulls, specialists believe that Homo erectus could speak.

Population genetics deals with the fluctuations over time of the frequencies of different alleles of the same gene in one or more populations, under the influence of natural selection, genetic drift, mutations and migrations, and seeks to explain adaptation and speciation. This application gave birth to neo-Darwinism. It makes it possible to understand the mechanisms of conservation and/or disappearance of populations and/or species. The population is a set of individuals which presents a reproductive unit: all the individuals have the same probability of interbreeding, but reproduce less or not with neighboring populations. A population is determined by spatial and temporal criteria and by a collective genome, the sum of individual genotypes: it is not a species. This population is a model, it only very rarely corresponds to reality.

Predicting the genetic variability of a population is very difficult to achieve due to mutations, simultaneous transmission of multiple genes, etc. To avoid these problems, an ideal and practical model has been developed for the numerous mathematical studies of population genetics: allele frequencies and genotypes follow the Hardy-Weinberg law, a reference model in population genetics. This law states that allele frequencies and genotype frequencies remain stable from generation to generation. This is just a model!

Polymorphism: in a population, a gene is said to be polymorphic if it has at least two alleles with a frequency greater than or equal to 1%. Otherwise, if the gene still exists in multiple copies, it is polyallelic. A polymorphic gene is necessarily polyallelic. Genetic variability is the result of mutations that cause the appearance of new alleles. Mutations, the founder effect, genetic drift and varying selection pressures lead to increasingly large genetic differences.

Mutations, the founder effect, genetic drift and varying selection pressures lead to increasingly large genetic differences. While migrations are the occasion for the transmission of alleles from one population to another, genetic drift and selection cause variations in allele frequency internally within populations. This model is intuitively justified: it is clear that all the individuals of a generation will not produce the same number of offspring; some will not have children (will not pass on any genes), others will have a large family and pass on several copies of their genes to the next generation. If the population is large, the loss of a copy of a certain allele present in an individual without descendants will be compensated by the fact that another individual with the same allele will have several descendants. In this way, allele frequencies fluctuate little in large populations.

Consequences of genetic drift

* The inbreeding of the population will increase.

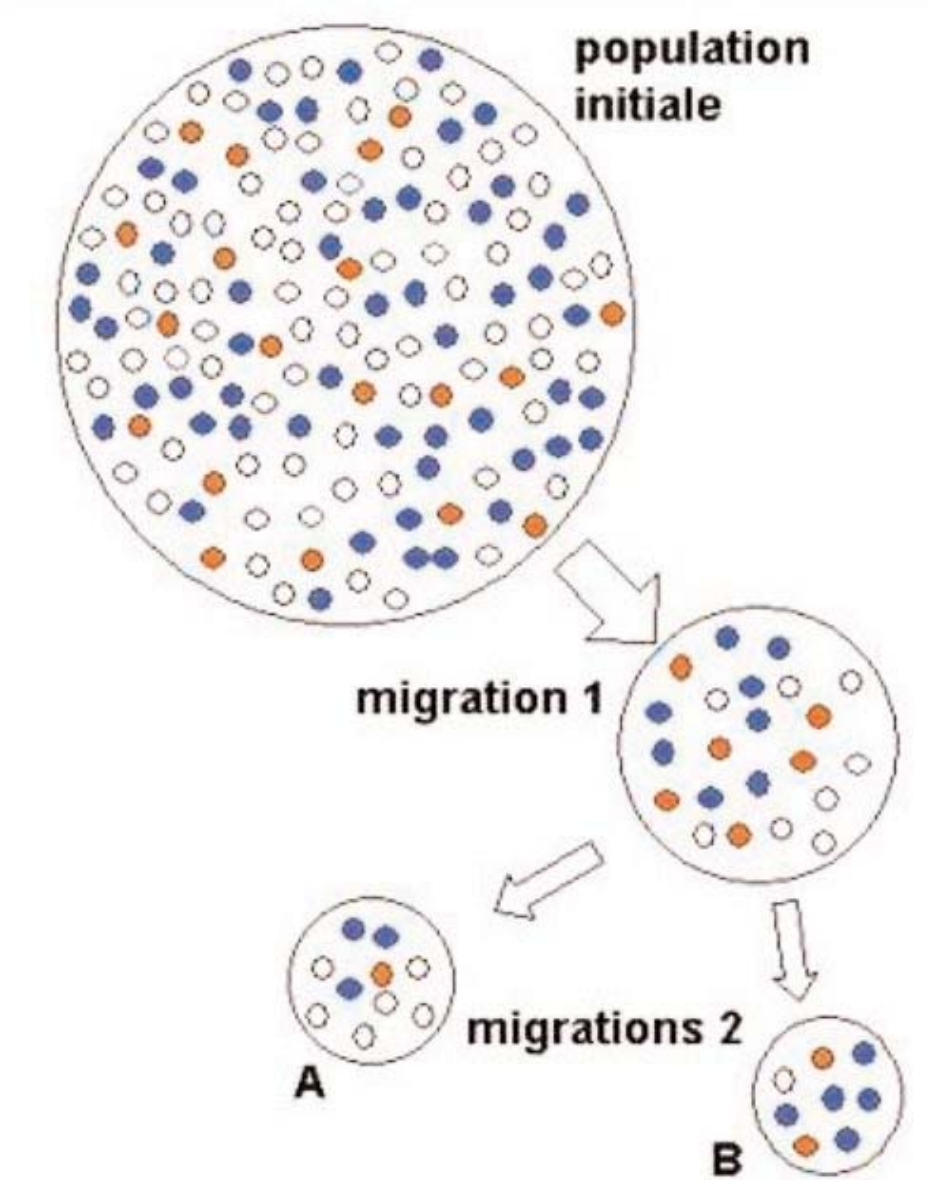
* The number of homozygous individuals will also increase.

* Allele frequencies fluctuate from generation to generation

* The amplitude of these fluctuations will be greater the smaller the population.

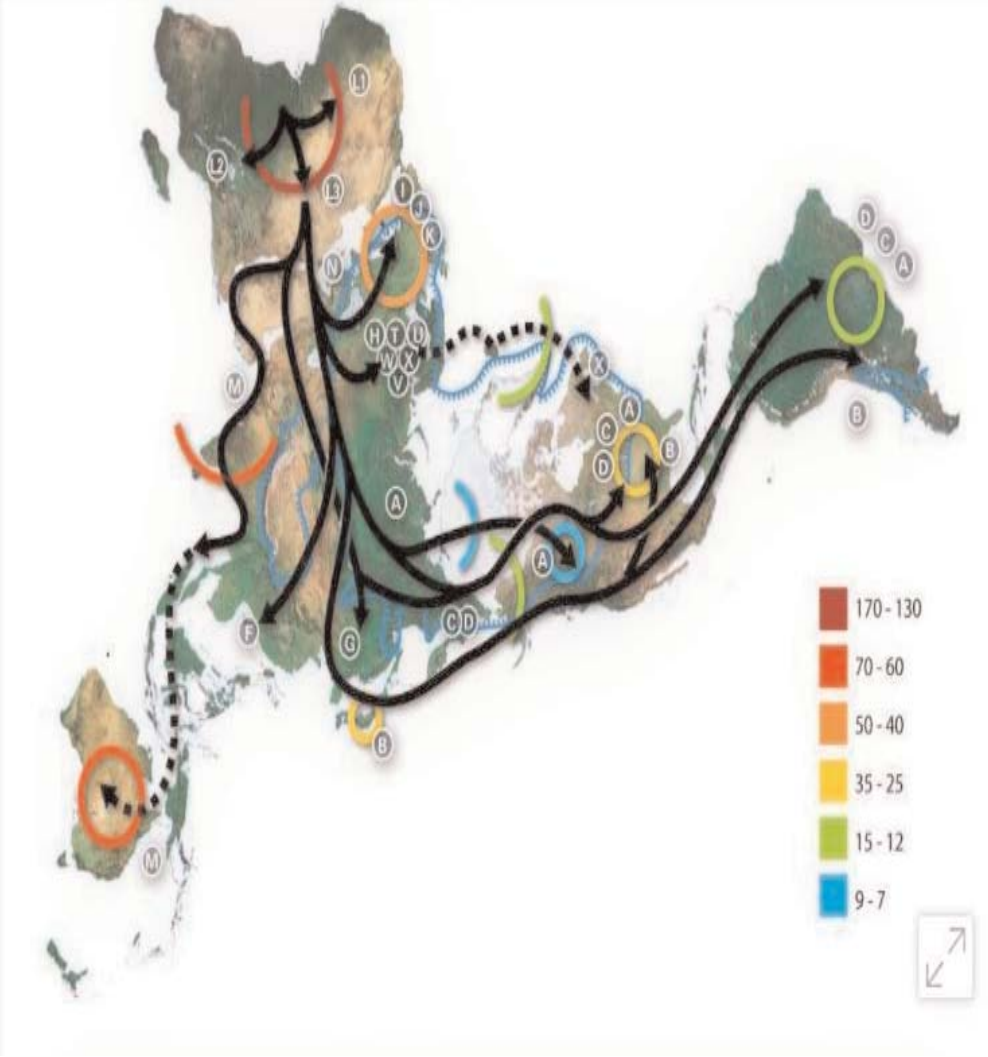
* Populations descended from a parent population will differentiate genetically

Consider that two populations separate at some point. They will initially have the same allele frequencies, but they will experience independent genetic drift processes. Each of the populations will have allele frequencies that change randomly over time. They will therefore diverge genetically. The genetic variability of the species will increase, especially since it will be composed of small populations isolated from each other. The allele frequency of a migratory group is often not representative of the population from which it came. This is the founder effect.



There are three genes present in the starting population of our example with a lot of whites, a little less blues and some reds. After a first migration, the white genes and blues are equally represented, but red genes are overrepresented,migrants with this "a lot" gene, those who are stayed less. We see during the two following migrations that the distribution changes again... we can clearly see that the humans who are parties have taken some genes, left others... and some genes may have disappeared.

Thus blood group B, very present in Asia, land of origin of small populations of hunter-gatherers who crossed Beringia to colonize America, is almost non- existent in current Amerindian populations: lost on the way, no doubt! Despite all these hazards, any man can have descendants with any woman on the planet and their descendants will be fertile, we all see it days , so we are still the same and unique species Homo sapiens sapiens is the very definition of the species!



Migrations

Nomadic peoples whose economy is based on hunting and picking have often been taken as an example of a way of life characteristic of the Paleolithic period, a phase representing at least 95% of human history. The examination of such a society and, in particular , the question of international migration at the time prehistory reveals similarities and differences that could us reflect and think better about modern migrations... We have traced the kinship of the mitochondrial DNAs (therefore of origin maternal) on samples from all over the planet and we obtain amap of colonization of the Earth during human history which is approximately the same as that obtained with the fossils and the logical deductions that we have been able to make of the climate and the different dates. The genetic gap being all the greater as the separation is old, it also corresponds to a kind of dating.

Migration and "mixing" of men

If we now turn to history... Migrations have continued in successive waves, more or less important according to the periods but in a sufficient way to "mix" the peoples throughout history. The migrations were from east to west, and from north to south, a few exceptions .

There is more of hundred years, in 1910 and 1911, the archaeologists have found thirteen teeth in a cave in La Cotte of St - Brélade on the island of Jersey. .

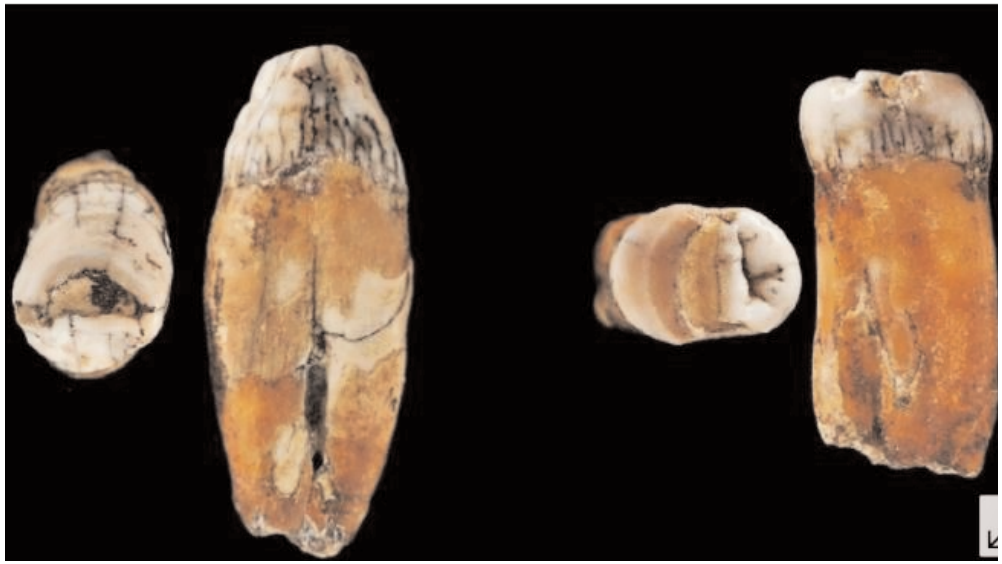
According to initial analyses, they belong to one Neanderthal man . A group of scientists from London Museum of Natural History , from the University of Kent and the Max-Planck Institute for Evolutionary Anthropology have decided to update their dated description . The new ones elements thus obtained redefine supposed history of these teeth .

They belong to two individuals , possibly born of love between Neanderthals and Homo sapiens.

A recent dating of the sediments collected at the same time as the teeth allows us to estimate their age: 48,000 years before our era. This is one of the most recent Neanderthal remains that we know of, since it seems to have disappeared around 40,000 BC. The scientists think that during this period Neanderthals could have meet their cousin Homo sapiens in this region of Europe.

Teeth of Neanderthals and Homo sapiens
The morphological analysis of the 13 teeth brings its batch of indices supporting the thesis of an encounter and a reproduction between the two human species . All teeth have their own characteristics to Neanderthals, namely the dimensions of the crown and of the root, as well as the shape of the latter, which are comparable to other known Neanderthal teeth, but they also have their own structures. to the teeth of modern men. The scientists hypothesis that these teeth belong to individuals whose parents are mixed between Neanderthals and Homo sapiens.

Some researchers have argued for some time that innovations that appeared at this time could have their source in Homo sapiens. On the Bacho Kiro website, you can also observe the presence of cave bear teeth transformed into pendants and some of which are surprisingly similar to ornaments later made by Neanderthals in Western Europe.



They would therefore have adopted technologies and a culture initially brought by Homo sapiens, which is not so surprising when we remember that we have evidence of hybridization between these hominids.

Personal ornaments and bone tools from Bacho Kiro cave (Bulgaria) in Hublin et al., 2020.

Personal ornaments and bone tools from Grotte du Renne, Arcy-sur-Cure, France. Modified from Fig.1 Caron F, d'Errico F, Del Moral P, Santos F, Zilhão J (2011) The Reality of Neandertal Symbolic Behavior at the Grotte du Renne, Arcy-sur-Cure, France. PLOS ONE 6(6): e21545. https://doi.org/10.1371/journal.pone.0021545

Something to add a new piece to the debates on this question because it now appears clear that the first Homo sapiens arrived in Europe 5,000 years earlier than generally believed accepted so far. Especially since we know that about 8,000 years later , it is Homo sapiens which takes the ascendancy on the continent with the definitive extinction of the Neanderthals.

HOMO SAPIENS

Homo sapiens, also called modern man, appeared in Africa. The oldest known representatives of our species have 300,000 years and were exhumed in Morocco, on the site of Jbel Irhoud . We have long believed that they had left their "cradle" only much more later , some 70,000 years ago, during a major wave.

But in recent years, discoveries have constantly challenged causes this theory, always advancing the date of their first migrations and extending the area of their dispersal. Apidima 1 has been discovered in front of another skull, dubbed Apidima 2. According to the study - and the presence on the occipital bone of a horizontal bony bulge - it would be a 170,000 year old Neanderthal.

This new discovery reinforces the idea that multiple dispersions of human beings outside Africa have occurred. The migratory movement and the colonization of Eurasia are surely much more complex than we thought. Rather than a single hominid outing from Africa to populate Europe and Asia, there must have been several dispersals , some not giving rise to permanent settlements.

The vault of Misliya cave collapsed about 160 000 years ago , making it possible to protect this fossil until today and other materials and objects buried in the sediments. Proofs archaeological evidence reveals that its occupants were hunters capable of killing large game such as aurochs, Persian deer and gazelles, and that they controlled the use of fire in the homes . They also made stone tools similar to those found among the oldest modern humans in Africa.

Other older fossils of modern humans have been found in Africa, but the periods and migration routes of Homo sapiens outside the African continent are essential to understanding the evolution of our species.

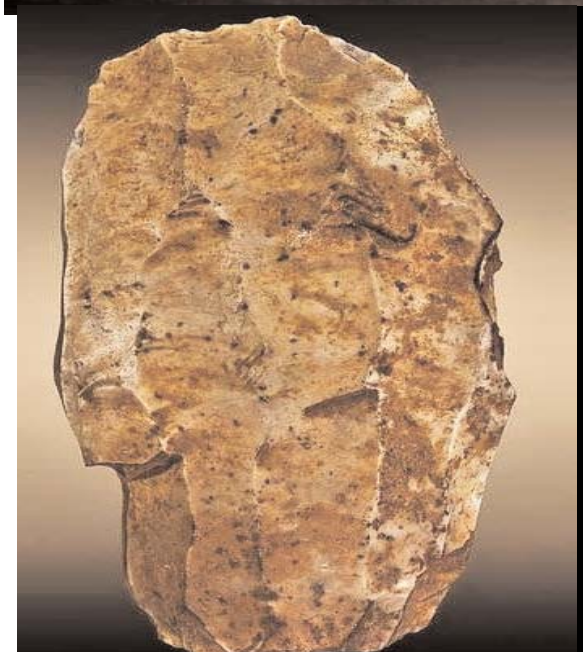
A very important corridor for hominid migrations, the Near East has been occupied at different times by modern humans and Neanderthals. This latest finding opens up the possibility between these species, and genetic mixtures between different local populations much earlier than previously thought.

In fact, the clues found at Misliya corroborate the hypotheses based on genetic data that modern humans migrated from Africa more than 220,000 years ago.

Several discoveries in Asia push back also the date of the first appearance of modern humans in this part of the world, and therefore their exit from Africa. This discovery contributes to a better understanding of our origins. In the Upper Paleolithic, Homo sapiens sapiens , invented the art (caves , figurines carved in ivory, etc.) and made tools increasingly economical , first , but more sophisticated, more diverse and efficient, with blades and slats, and tiny cut pieces called microburins , microliths. He used bones, antlers and ivory to make spears , needles and harpoons.

The artistic manifestations of the Mesolithic are characterized by geometric or schematic figures engraved or painted (to ochre) on rock walls, on pebbles or stone slabs and on objects. There are also pendants and carved figurines.

Mesolithic cultures are distinguished by miniaturization and the geometry of stone tools. The period is marked by increased regionalization of lithic industries. The Neolithic marks a decisive turning point. The use of pottery (that the abandonment of nomadism allowed) and that of polished stone tools are the characteristic features. It is the form and decoration of pottery which will serve as a reference.



We are one and only one big family

As we saw in the previous chapter, it seems accepted , by the scientific community in any case, that we have all common ancestors in Africa. Each of us has 2 parents who each have 2 parents etc. or 2n ... ancestors. Consider the time now : around the year 1200, i.e. 33 generations ago, each of we had 233 ancestors, i.e. more than 8 billion... However, the population world barely reached its first billion around 1830... reduce this number of ancestors and therefore increase our kinship and we can see that we must, mathematically, all be parents! Especially since, the more we go back in time, less people there were, the more common ancestors we have...

So all of our genes are copies of the genes of our common ancestors, the first men. And a thousand centuries is too short for that many important changes have taken place. The colour of the skin: a simple matter of regulatory genes. We all have produce melanin (a natural pigment) under the genetic control of the same genes.

The melanocytes are skin cells that have extensions and that contain cellular organelles which, for their part, contain melanin which comes in two forms in man , both forms being present in all cases but in different proportions: eumelanin granules, round and tender, are found in greater numbers in black and yellow skin; pellets of pheomelanin , plus irregular , present in larger number in fair skin, especially in redheads. This is the amount of melanin produced in the melanocytes which more or less darkens our epidermis . At the same time, the amount and intensity of rays of the sun influence our body, which produces more or less melanin : this is the tan.

Populations continuously exposed to the sun develop a permanent tan . From a region tropical in the north, you encounter growing populations clear , without breaking up. He is impossible to determine from how much an individual is white , black or yellow because all the shades are present.

CLIMATE AND MIGRATION
Natural Climate Changes

For a long time, scientists have suspected the changes natural climates to have played a role in the evolution of the genus Homo. Today, thanks to an unprecedented simulation, researchers have managed to confirm this. Global warming that we live today is, "unequivocally possible", the result of our greenhouse gas emissions. But speak past , the climate of our Earth has experienced changes in sunshine according to what scientists call the cycle of Milankovitch . A consequence in particular of the eccentricity of the orbit terrestrial , of the obliquity of the axis of rotation of our Planet by relation to the plane of the ecliptic and the precession of the equinoxes. These changes have shaped the evolution humans over the past two million years. It must be said that our ancestors were probably more closely related to their environment than us. A drying up river and now it was time to break camp. However, the hypothesis of changes that have helped to stimulate developments evolutionary changes of the genus Homo -- changes intended to make the humans more adaptable and able to survive harsh conditions varied -- remained difficult to prove until then. Due to lack of data climatic -- often from ice cores or sediments marine -- geographically related to fossil finds archaic humans .

This problem, the researchers are finally managed to circumvent it by modeling the changes in conditions environmental conditions over the last two million years and by incorporating climate change linked to the cycle of Milankovitch .

For six months, the simulation ran on a supercomputer generating some 500 terabytes of data and representing the responses to increasing and decreasing ice caps glacial , to changes in past gas concentrations at greenhouse effect, as well as the marked transition in the frequency of cycles about 1 million years ago. The objective being to specify the climate that could reign in the regions for which researchers have archaeological artefacts and fossil records documenting the presence of several species of hominids , including Homo erectus, Homo heidelbergensis or Homo neanderthalensis and ours, Homo sapiens. In everything , more than 3,000 geo-chronologically constrained fossils.

Adaptations that end up evolving under climate pressure. From there, the researchers claim to be able to tell us the complexity of how which different groups of hominids dispersed on our Earth over the centuries. Scatters which they now link to climate models affecting, for example, temperatures and food availability. According to them, the climate played a fundamental role in the evolution of the genus Homo.

We are what we are because we succeeded in adapting over millennia to slow changes in climate past . This work shows how species have evolved adaptations cultural , such as firebending, allowing them to survive in colder environments, for example. How also , certain environmental stresses -- droughts in particular -- reduced the size of the most vulnerable populations. Lowering the diversity of the gene pool of these species. And not allowing the survival of individuals with a advantage which would then be transmitted to their descendants.

This genetic modification took place over millions of years.
And some of those benefits may have been so significant that they triggered the transition from one Homo species to another. Indeed, by studying the contact zones -- the habitats of the different species that overlap in space and inthe researchers reconstructed a family tree of hominids.

A strikingly similar climate-based tree to that obtained from genetic data or morphological analyses. The researchers even go a little further by suggesting the evolution of the genus Homo cannot be fully explained without integrate climatic factors that have affected ecosystems -- the availability of water and food, for example -- during the Pleistocene.

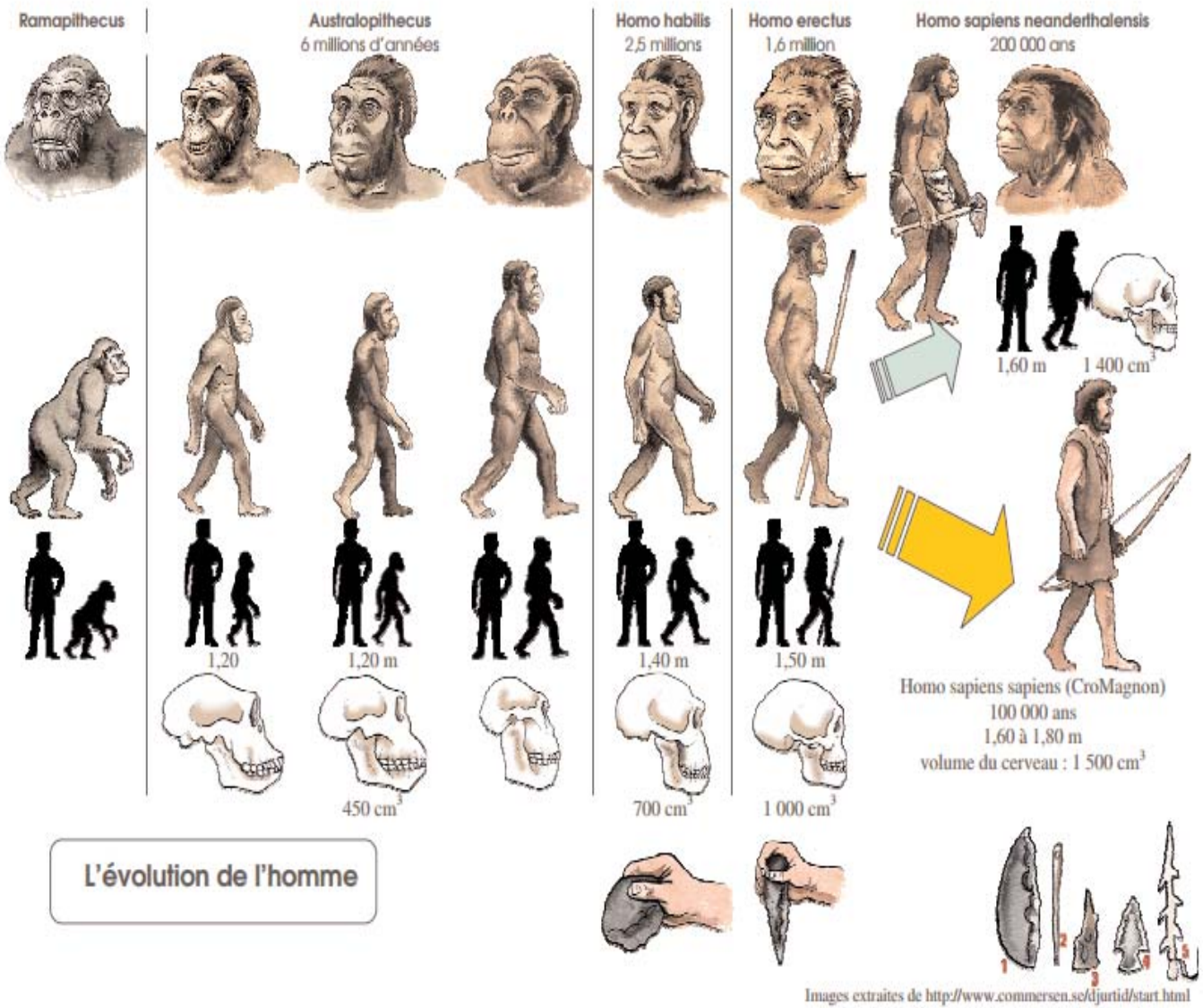
But the idea will still have to be confirmed by new surveys that will examine the fossil record at the search for undiscovered paleo-environmental clues. Humanity today faces brutal global warming. Researchers warn us. climate change rendered the genus Homo vulnerable and powerless in the past. That could reproduce. Homo sapiens is the only species of the genus Homo to have succeeded in crossing the ages to arrive there up to us.

A study now suggests that climate change past are what caused the extinction of our cousins : their inability to adapt to global warming or cooling , sometimes deep, that naturally knows our Planet. Yet anthropologists note that our ancestors have tried hard to survive. They tamed the fire , made tools and weapons, clothes too.

They even headed for warmer regions when the temperatures started to drop. But this does not seem to have been sufficient when the climatic conditions have become too extreme for them. Researchers estimate that climate change past have got the better of several species of the genus Homo.

A disturbing discovery at a time when "our own species , with anthropogenic global warming, the branch on which she sits". To come to this conclusion, the researchers worked on more than 2,750 archives archaeological sites and a high-resolution climate emulator. This one gave them the temperature, precipitation and other information over the last five million years. They were thus able to show than Homo erectus, Homo heidelbergensis and Homo neanderthalensis have lost a significant part of their climatic niche just before to go out. At the very moment when sudden changes and unfavorable global climate events were occurring. In the case of Neanderthals, things were probably made even worse by competition with Homo sapiens. "A thunderous warning message at a time when humanity is facing global warming unprecedented ", underline the researchers.

The Anthropocene era we are still in.



Images extraites de http://www.commersen.se/djurtid/start.html

The five biggest mass extinctions

1. Ordovician extinction
When: about 445 million years ago.
Rate of disappearance of species: 60 to 70%.
Probable cause: short but intense ice age.

During this period, life was mainly found in the oceans. Experts believe that the rapid formation of glaciers froze the most of the water on the planet, causing the sea level . Marine organisms such as sponges and seaweed paid the price, as did seashells and cephalopods and jawless fish called ostracoderms.

2. Devonian extinction
When ? : about 360 to 375 million years ago.
Species disappearance rate: up to 75%.
Probable cause: depletion of oxygen in the oceans.

About 252 million years ago, the Earth experienced one of the worst mass extinctions in its history. We know today that this crisis was accompanied, if not caused, by a change . The many studies that have studies of the paleoclimate at the end of the Permian indeed show that this geological period is marked by an important and rapid warming , which is certainly the most catastrophic of all the times.

Again, marine organisms were the most affected. fluctuation sea level, climate change or the impact of an asteroid are suspected of being responsible. According to a the proliferation of terrestrial plants has led to a anoxia (lack of oxygen) in surface waters. trilobites, arthropods from the bottom of the oceans, have suffered in particular.

3. Permian extinction
When ? : about 252 million years ago.
Species disappearance rate: 95%.
Probable causes: asteroid impacts, volcanic activity.

Sometimes referred to as the "mother of all extinctions", this crisis large-scale biological disaster has devastated the oceans and the land. She is the only one to have also practically seen the disappearance of insects . Some scientists believe it occurred on million years, others only over 200,000 years.

The trilobites that had survived the first two extinctions eventually disappeared, as did some sharks and bony fish. On land, the moschops , herbivorous reptiles of several meters long , also ended up dying. So far, volcanic activity in the Siberian Traps was recognized as the cause of the terrible global warming that has caused the mass extinction at the end of the Permian. A news study shows that the climatic catastrophe was already well engaged for hundreds of millions of years. In question : a series of super eruptions in Australia.

At the level of the south-east coast, the Australian continent indeed bears the marks of ancient volcanoes, which could have been at the origin of a series of catastrophic eruptions, capable of severely degrading the earth's climate. Today, the witnesses of these super-eruptions are visible in Australian sedimentary series.

Australia's super eruptions would have been marked by catastrophic explosions , projecting quantities into the atmosphere huge amounts of ash and gas. These ash deposits are today visible in many sedimentary series, a little all over the east of the country. For researchers, it could be the most violent eruptions that the Earth has ever known.

They estimate that these volcanoes would have produced more than 150,000 km 3 of volcanic material for 4 million years, making them comparable to the Yellowstone super volcano in the United States and the Taupo in New Zealand. By way of comparison, Vesuvius, when of its eruption in the year 79 which petrified the city of Pompeii, produced only 3 to 4 km3 of ash and other debris. It is likely that these explosive eruptions were accompanied by a massive release of greenhouse gases, initiating the climate change at the origin of the biological crisis marking the end of the Permian.

The evidence of an environmental catastrophe caused by these super eruptions are also clearly visible in the sedimentary rocks. Eastern Australian coal deposits show in effect that this region was previously covered with forests, completely reduced to ashes during volcanic eruptions.

The climatic and biological disaster was therefore already well advanced when the Siberian Traps entered into activity, worsening an already critical situation. It should be remembered that 250 million years ago, Australia was not, from a distance, in its current position. Twinned with Antarctica, it made part of the supercontinent Gondwana, located at the level of the south pole . It is only much later, from 84 million years, that Australia broke away from Antarctica and began its great northward migration, with the opening of the Southeast Ocean Indian.

The Permian-Triassic biological crisis represented a loss of about 96% of marine species and 70% of terrestrial vertebrates there are about 252 million years old. The first dates left think that the extinctions were synchronous on the supercontinent of the time with that of the oceans.

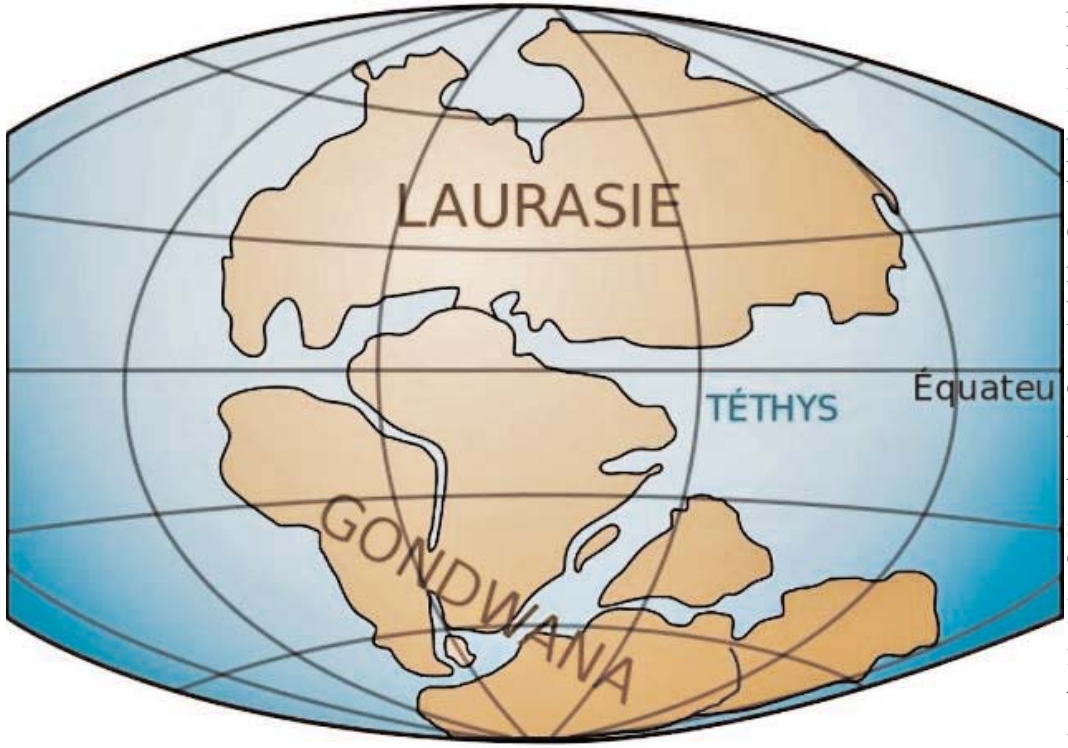
By delving into the Earth's sedimentary archives, geologists and paleontologists noted, a long time ago already, a sudden break in the fossilized fauna and flora dating from there 252 million years old. At that time, the period geological period known as the Permian ends while there is still a only continent, Pangea, and only one ocean, Panthalassa . In studying this cut, the researchers came to the conclusion that at that time , the biosphere of the geochemist Vladimir Vernadsky would have suffered its most violent biological crisis, the famous Great Dying , at the interface of the Permian and the Triassic as paleontologists say.

Indeed, in the oceans, it is spectacular with about 96% of the species that disappeared at that time, in particular the famous trilobites highly prized by fossil enthusiasts. On the continents, these are about 70% of vertebrates.

The Great Permian Triassic Extinction is explained by gigantic magmatic outpourings having started a few hundred thousands of years before its end . These effusions are found in Siberia, but also in Emeishan Province , China. The traps of Siberia, analogous to those of the Deccan in India, would have emitted large quantities of carbon dioxide which would therefore have produced global warming.

Land in Australia with two similar layers, which is not hardly surprising since South Africa and Australia were part of of Gondwana, give for the beginning of the extinction a later old , but this time around 400,000 years old. Clearly, life on the Pangea continent had already been heavily affected hundreds of thousands of years before that of the oceans of the Panthalassa . This discovery is a surprise and that is why the researchers have concluded in the article they published "that greater attention should be given to a more gradual, complex and nuance of terrestrial ecosystems during the Changhsingian (the last part of the Permian) and, possibly, the beginning of the Triassic".

The researchers started by transposing to the state of the Earth from the Permian, i.e. while the supercontinent of Pangea was still there, a climate model global like those we 're running today on computers . Then they have changed the composition of the atmosphere towards the end of the Permian, which was not initially to be very far from that of Current earth, adding injection presumed carbon dioxide resulting from the Siberian traps .



This change was driven from way to reproduce the increase average temperature of 10°C at tropical ocean level of the time, temperature of which the memory is well in the archives of the blue planet, and decipherable using the geochemistry .

The climate model then predicts that the oceans have lost about 80% of their oxygen. In fact, half of the bottom surface sailors would have become anoxic at great depths, that is - say devoid of oxygen. However, these areas are not anoxic which have decimated marine organisms because the majority of them was not there, but rather the hypoxic zones, i.e. depleted of oxygen.

To understand what happened in detail, the researchers considered available data on marine organisms related to those of the Permian and this, from the point of view of their resistance to rising temperatures and decreasing amounts dissolved oxygen . They are thus arrived at the conclusion than those living at the level of tropics , already accustomed to a lower amount of O2, could partially survive rising towards higher latitudes high , where the oceans, initially richer in oxygen due to temperature lower , could still contain enough for them. The organisms living in these climates colder would not have had this chance.

To test this hypothesis, they then compiled the data paleontological studies concerning species from the Permian to Trias and their geographical locations. The species most far from the equator were indeed those which had the most suffered . Every form of life has thus literally suffocated in the warm late Permian oceans .

Acid rain, volcanic winters and global warming: the combo for a mass extinction. The study, conducted in Sydney Basin, Australia, shows that the disappearance of continental species coincides with a modification clear of the atmospheric composition. Measurements indicate a significant increase in atmospheric concentration in sulphates, in connection with the dispersion of large quantities aerosols from the eruption of the Trapps of Siberia, ongoing at that time. The presence of these aerosols would have resulted in sulfuric acid rains, in parallel with significant climatic variations .

Aerosols formed from the original sulfur volcanic are indeed well known to be at the origin of brief volcanic winters preceding longer periods of global warming. These brief drops in temperature are related to the ability of aerosols to reflect sunlight, preventing solar energy from reaching the ground.

This discovery is disturbing. If we continue on the trajectory current CO2 emissions, the oceans will get closer at the horizon 2100 of the Permian oceans, which means that we can expect mass extinctions if nothing is done.

4. Triassic Extinction
When ? : about 200 million years ago.
Rate of disappearance of species: 70 to 80%.
Probable causes: multiple, still under discussion.

The mysterious Triassic extinction wiped out many great species , including most archosaurs, the ancestors of dinosaurs and from which today's birds and crocodiles are descended. Most large amphibians have also disappeared. One theory evokes massive eruptions of lava at the time of the breakup of Pangea, the last supercontinent, eruptions accompanied by enormous volumes of carbon dioxide having caused rampant global warming. other scientists suspect asteroids, but no crater has yet been identified.

5. Cretaceous extinction
When ? : about 66 million years ago.
Species disappearance rate: 75%.
Probable cause: impact of an asteroid.

The discovery of a huge crater in what is today the Peninsula supports the hypothesis that the impact of an asteroid is responsible for this crisis having seen the disappearance non -avian dinosaurs like T-Rex and triceratops .

But most mammals, turtles, crocodiles, frogs and birds survived, as did marine life, including sharks, starfish and sea urchins. Without the dinosaurs , mammals proliferated, leading to birth of homo sapiens, the species responsible for the probable 6th extinction.
A lesson to remember
It was therefore not a sudden and unique event that led to a catastrophe , but a cascading sequence of small long-term changes . This study shows that a warming weather can cause environmental catastrophe major by a set of uncontrollable sequences. Crisis caused by the five mass extinctions marks a turning point milestone in the history of life on Earth. Moreover, it will be necessary several million years for biodiversity to regain its level after each crisis.

6. Anthropogenic extinction
The erosion of biodiversity noted by scientists in this beginning of the 21st century may lead us to a sixth extinction mass of life on Earth. "In the five previous extinctions mass , we lost 75% of the species", explains Robert Watson, head of the UN group of experts on biodiversity (IPBES).

Over the last 500 years, the Earth has lost about 2% and is therefore still far from this threshold, he continues. But the rate of disappearance up to several hundred times faster than the average of the 10 million years that have just passed, according to the IPBES report published on May 6, 2019. At this speed, the mark could be reached in a few hundred years only .

Biodiversity is the very life of the planet

And much more, it is "the variability of living organisms of any origin including, inter alia, terrestrial ecosystems, marine and other aquatic ecosystems, and complex ecological systems of which they are a part". Biodiversity cannot therefore be summed up not in the species inventory. To decipher it, you must have a global approach to life - from micro-organisms to animals in passing through the plants -, which integrates the three levels that are the genes , species and ecosystems. And the man in all of that ? He is at the heart of biodiversity and constantly interacts with it. If it is necessary to find a utilitarian cause for the protection of the biodiversity , it suffices to mention that man draws his resources , but also the water and air necessary for life and the raw materials necessary for its survival

The first human habitats are linked to past climate change.

By combining the largest database of well-dated fossil remains and archaeological artefacts with an unprecedented new supercomputer model simulating Earth's climatic history over the past two million years, the expert team in climate modelling, anthropology and ecology has been able to determine the environmental conditions under which archaic humans probably lived and provides clear evidence of a link between astronomically induced climate change and human evolution (Fig1).

The impact of climate change on human evolution has long been suspected, but is difficult to demonstrate due to the paucity of climate records near human fossil sites. To circumvent this problem, the team studied the climate of its computer simulation at the time and in the places where humans lived, according to archaeological records. This study revealed the preferred environmental conditions of different groups of hominids.

From there, the team searched for all the places and times when those conditions were present in the model, creating time-varying maps of potential hominid habitats.

"Even though different groups of archaic humans preferred different climatic environments, their habitats all responded to climatic changes caused by astronomical alterations in the Earth's axial wobble, tilt, and orbital eccen-

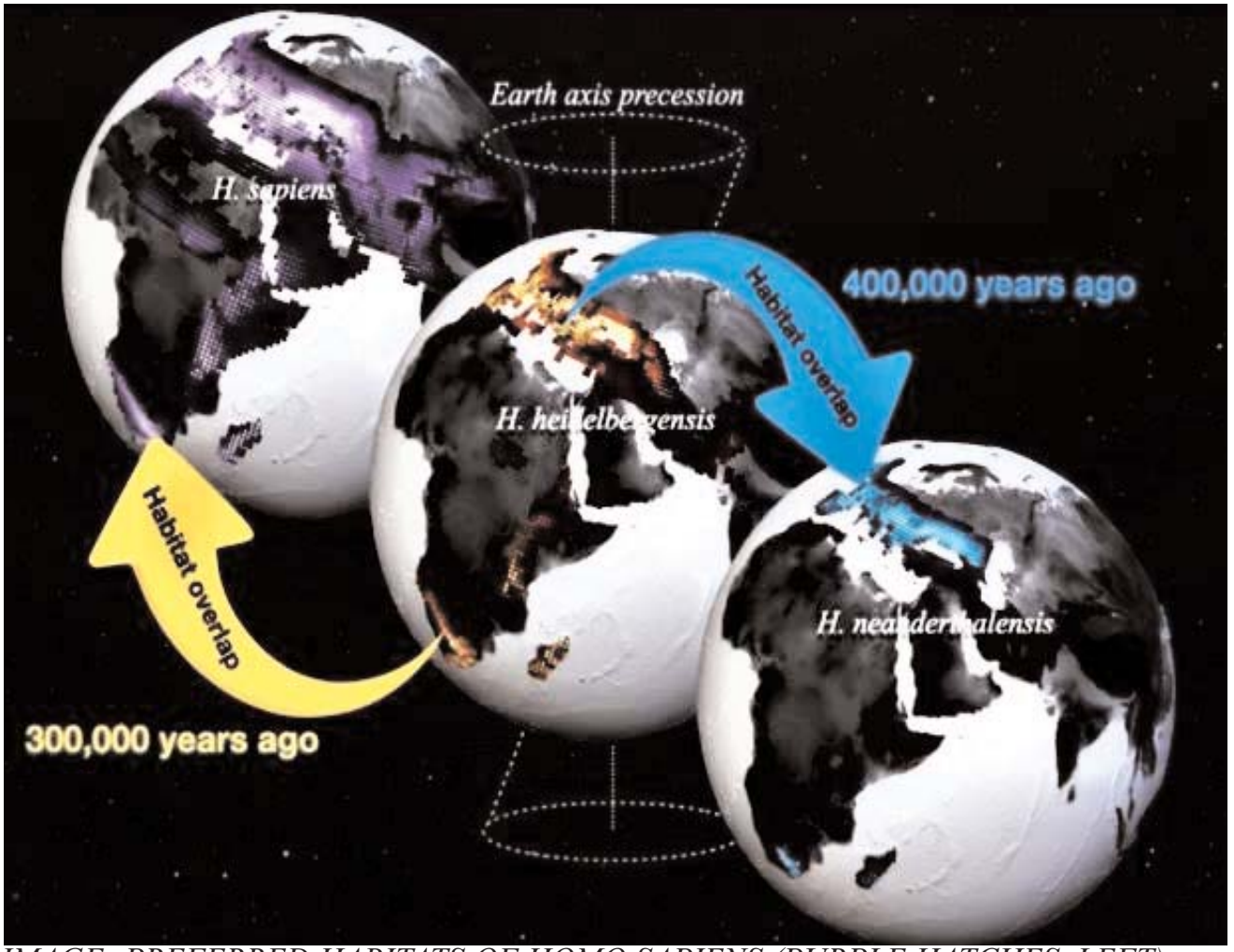


IMAGE: PREFERRED HABITATS OF HOMO SAPIENS (PURPLE HATCHES, LEFT), HOMO HEIDELBERGENSIS (RED HATCHES, MIDDLE), HOMO NEANDERTHALENSIS (BLUE HATCHES, RIGHT) CALCULATED FROM A NEW PALEOCLIMATIC MODEL SIMULATION CONDUCTED AT THE IBS CENTER OF CLIMATE PHYSICS AND A COMPILATION OF FOSSIL AND ARCHAEOLOGICAL DATA.

CLEARER VALUES INDICATE BETTER HABITAT SUITABILITY. THE DATES (1 KA = 1000 YEARS BEFORE PRESENT) REFER TO THE ESTIMATED AGES OF THE YOUNGEST AND OLDEST FOSSILS USED IN THE STUDY.
CREDIT: INSTITUTE OF BASIC SCIENCES

tricity, on timescales ranging from 21 to 400,000 years," said Axel Timmermann, lead author of the study and director of the IBS Center for Climate Physics (ICCP) at Pusan National University in South Korea.

To test the robustness of the link between climate and human habitats, the scientists repeated their analysis, but shuffled the ages of the fossils like a game of cards. If past changes in climate variables had no bearing on where and when humans lived, both methods would have resulted in the same habitats. However, the researchers found significant differences in the habitat patterns of the three most recent hominid groups (Homo sapiens, Homo neanderthalensis, and Homo heidelbergensis) using mixed and realistic fossil ages.

This result implies that at least over the past 500 millennia, the actual sequence of past climate change, including glacial cycles, has played a central role in determining where different hominid groups lived and where their remains were found," Professor Timmermann said.

"The next question we wanted to answer was whether the habitats of different human species overlapped in space and time. Past contact zones provide crucial information about species successions and potential admixtures. "said Professor Pasquale Raia of the Università di Napoli Federico II, in Naples, Italy, who together with his research team compiled all the data relating to the human fossils and archaeological objects used in this study. . From the contact zone analysis, the researchers then constructed a hominid family tree, according to which Neanderthals and possibly Denisovans arose from the Eurasian clade of Homo heidelbergensis around 500-400,000 years ago, while the roots of Homo sapiens can be traced back to southern African populations of late Homo heidelbergensis, around 300,000 years ago.

Evidence shows that humans have been top predators for 2 million years.

Paleolithic cuisine was anything but lean and green, according to a 2021 study of the diets of our Pleistocene ancestors. For 2 million years, Homo sapiens and his ancestors gave up salad and ate meat, putting them at the top of the food chain.

It's not quite the balanced diet of berries, grains, and steaks you imagine when you think of "paleo" food. But according to anthropologists from Israel's Tel Aviv University and Minho University in Portugal, modern hunter-gatherers have given us the wrong impression of what we once ate.

"This comparison is futile, however, because 2 million years ago hunter-gatherer societies could hunt and consume elephants and other large animals - whereas today's hunter-gatherers did not. no access to such abundance," Miki Ben-Dor of Israel's Tel Aviv University said in April last year.

Hundreds of previous studies, covering topics as diverse as the anatomy and physiology of modern humans or the measurements of isotopes in the bones and teeth of ancient humans, show that we were primarily predators. of the first order until around 12,000 years ago.

It is all the more difficult to reconstruct the list of provisions of the hominids who lived 2.5 million years ago as the plant remains are not preserved as easily as the bones, teeth and shells of animals.

Other studies have used chemical analysis of bones and tooth enamel to find localized examples of diets high in plant matter. But it is not so simple to extrapolate these results to the whole of humanity.

We can find plenty of evidence of game hunting in the fossil record, but to determine what we have harvested, anthropologists have tra-

ditionally turned to modern ethnography, assuming that little has changed.

According to Ben-Dor and his colleagues, this is a huge mistake.

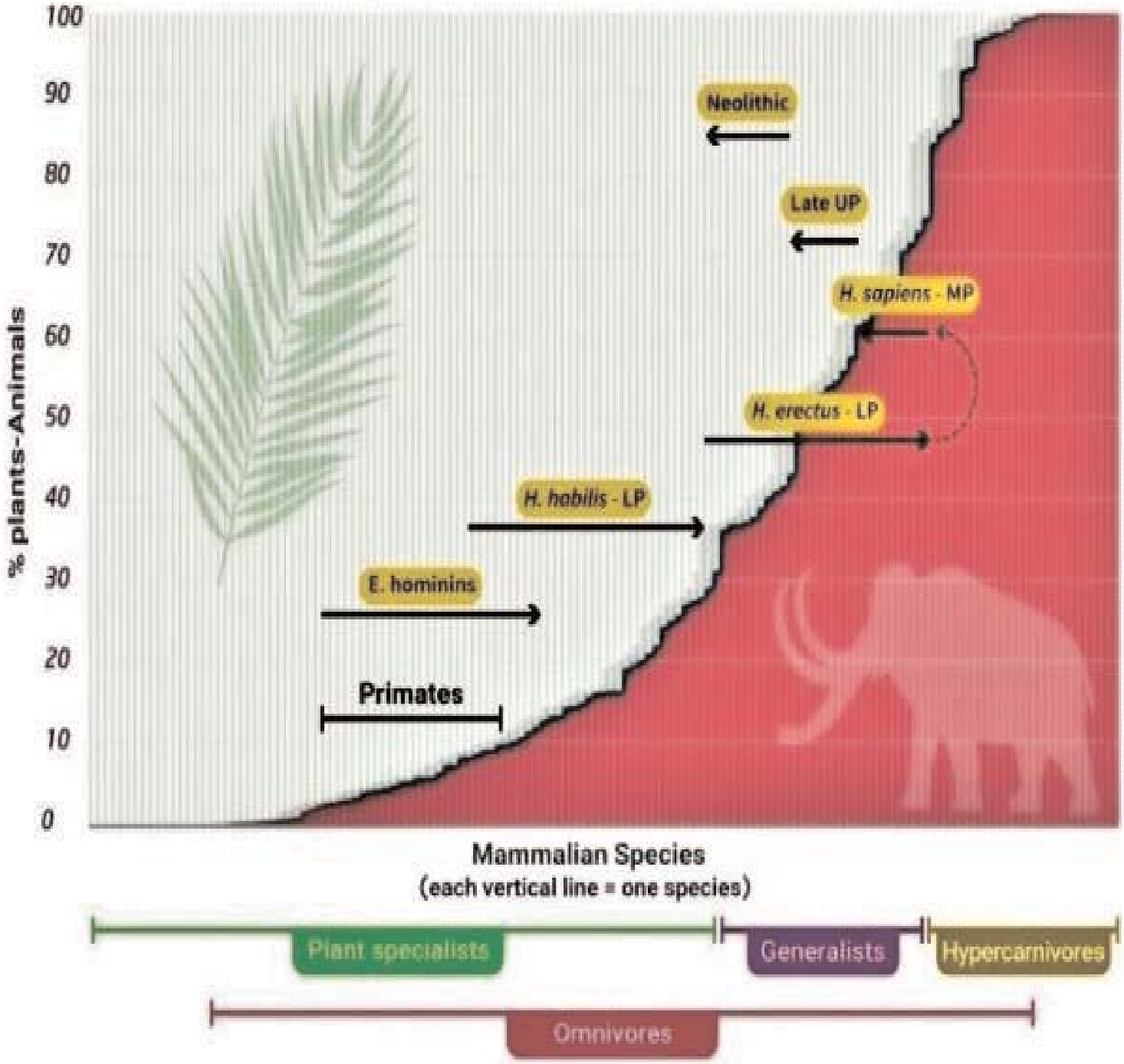
"The whole ecosystem has changed, and the conditions cannot be compared," Ben-Dor said.

The Pleistocene Epoch was a defining period in Earth's history for us humans. At the end of this period, we headed to the farthest corners of the globe, outliving all the other hominids on our branch of the family tree.

Dominated by the last great ice age, most of what is now Europe and North America was regularly buried under thick glaciers.

With so much water locked up in the form of ice, ecosystems around the world were very different from those we know today. Great beasts roamed the landscape, including mammoths, mastodons, and giant sloths, in far greater numbers than today.

Of course, it's no secret that Homo sapiens displayed uncanny ingenuity and endurance in hunting down



Above: Chart showing where Homo sapiens fell on the spectrum of carnivores and herbivores during the Pleistocene and Late Pleistocene (UP).

these huge meals. But how often they preyed on these herbivores was not so easy to determine. Rather than relying solely on the fossil record or making tenuous comparisons with pre-agricultural cultures, the researchers turned to the evidence in our own bodies and compared it with that of our closest cousins.

"We decided to use other methods to reconstruct the diet of Stone Age humans: to examine the memory stored in our own bodies, our metabolism, our genetics and our physical constitution," Ben-Dor said.
"Human behavior changes quickly, but evolution is slow. The body remembers."

For example, compared to other primates, our body needs more energy per unit body mass. Especially when it comes to our energy-hungry brains. Our social time, like when it comes to raising children, also limits the time we can spend foraging for food.

Our fat stores are larger and we can use them by quickly turning fat into ketones when the need arises. Unlike other omnivores, where fat cells are few but large, ours are small and numerous, echoing those of a predator. Our digestive systems are also eerily similar to those of animals higher up the food chain. Exceptionally strong stomach acid is just what we need to break down proteins and kill harmful bacteria that one would expect to find on a week-old mammoth chop. Even our genomes indicate that we are more dependent on a meat-rich diet than a sugar-rich diet.

"For example, geneticists have concluded that certain areas of the human genome have been closed off to allow for a high-fat diet, whereas in chimpanzees certain areas of the genome have been opened up to allow for a high-sugar diet," Ben said. -Golden.

The team's argument is broad, drawing on evidence of tool use, traces of trace elements and nitrogen isotopes in Paleolithic remains, and the wear and tear of teeth. This all tells a story where the trophic level of our genus - Homo's position in the food web - became highly carnivorous for us and our cousins, Homo erectus, around 2.5 million years ago, and remained so until the Upper Palaeolithic, around 11,700 years ago.

From here, studies of modern hunter-gatherer communities become a little more useful, as declining populations of large animals and the fragmentation of cultures around the world have led to increased plant consumption, which peaked with the neolithic revolution in agriculture.

This does not mean that we should eat more meat. Our evolutionary past is no guide to human health and, as the researchers point out, our world is no longer what it used to be.

But knowing where our ancestors were in the food web has a big impact on understanding everything from our own health and physiology to our influence on the environment in times past.

CLIMAT ET CIVILISATIONS

While most animals are content to adapt to natural constraints, bipeds will decide to emancipate themselves from them. A beautiful outbreak and finished the cold, the darkness, the predators!

Arrived in Europe, here they are looking with a dim eye at woolly rhinos, aurochs and other saber-toothed tigers. Never mind ! Some talented artists will tame these pests on the walls of the caves of Chauvet or Lascaux. And if that's not enough, let's be sure that the increasingly skilful and therefore efficient practice of hunting or fishing will have helped certain species to desert our neighborhood.

If we still discuss today their responsibility in the disappearance of the famous mammoths (12,000 BC) and several of their herbivorous colleagues, we must recognize that our dear Homo sapiens and Neanderthals are far from the image of Epinal. They already had, on their small scale, a significant impact on their environment.

Will we ever know if they haven't made dozens of plants disappear forever? Isn't it estimated that nearly 80% of large American mammals did not recover from their encounter with Man, once he had spotted the passage of the Bering Strait (12,000 BC). VS.) ? The predators have changed sides!

"Nature is a temple..." (Baudelaire)
About 10,000 years ago, our hunters became peasants. They begin to select and herd animals and plants and give birth to new species often unable to survive in the wild. Do you know that our breeds of cows or sheep are less than 150 years old?

As long as the land abounds, the first peasant communities do not show manners. They burn a patch of forest and sow seeds on the ashes. When the ground is exhausted, they go a little further to renew the operation. This primitive slash-and-burn agriculture, which destroys forest and humus, is still practiced from Brazil to Indonesia via tropical Africa and Madagascar.
Then, our dear ancestors transform the forests into permanent fields or rice paddies. They also founded cities to house an ever-growing population and dug the earth in search of precious minerals.

The climate has always been a concern for people, for whom it determines living conditions. He also asks many questions. What was the impact of the climate in the history of the world and the history of civilizations, on a large temporal scale? Can the location of the first historical civilizations be explained by particular climatic factors? Was the vigor of the Fertile Crescent, then of the Mediterranean, then of Europe, climatically inevitable?

There are relationships between the emergence of a civilization and climatic conditions. The climatic diversities observed between civilizations have a common denominator: climatic stress which tends to develop a culture of innovation. In particular, the specter of famines which invites us to domesticate nature in order to increase the abundance of food. Man has succeeded in freeing himself by various means from the constraints of his environment, but this has a cost.

The history of the world presents a geographical diversity of development that challenges: some regions have formed prosperous civilizations that have left many vestiges, while others have remained in the shadows during all this time. Why such diversity? The study highlights an essential common denominator: the existence of strong climatic stress, which tends to encourage material innovations and facilitate the transition from Prehistory to History.

Cereals of the Fertile Crescent

Requiring water, the first cereal crops developed on the banks of the rivers: Tigre and Euphrates, Nile, Indus, Yellow River and Yang-tse-Kiang. It is on their shores that the first great civilizations of Antiquity were born and flourished.

Previously, humans took their food directly from nature: they were "content" with picking it, picking it up, digging it up, fishing it or hunting it. In the Near East, the collection of wild cereals - engrain (small spelled), starch wheat, barley - which became locally abundant after the last ice age thus contributed to the food ration of the hunter-gatherers who populated the region. This "predatory economy" lasted until the middle of the tenth millennium BC, when certain human groups decided to cultivate wild cereals ..

It was an extremely recent founding event on the scale of human history. Indeed, if we "concentrated" the latter on a standard year of 365 days (the entry into the scene of the genus Homo, 2.5 million years ago, corresponding to January 1), agriculture would not be. only appeared on December 30 in the late morning!

Pl. 391.

A. Froment renflé. Triticum turgidum L.
B. Froment dur. Triticum durum Desf.
C. Froment de Pologne. Triticum polonicum L.
D. Froment Epeautre. Triticum Spelta L.

Contrary to a belief still widespread in the general public, the sedentarization, in the Middle East, of groups of nomads was not the consequence of the latter's decision to become peasants. Certainly, the cultivation and storage of crops are incompatible with itinerant life. But agriculture has in reality only reinforced sedentarization. The latter had in fact preceded by several centuries the cultivation of soils and the breeding of animals.

In the Fertile Crescent, agriculture was therefore born in villages that had been established for a long time, and which (already) presented a complex and hierarchical social structure. These permanent habitats had been created in sites sufficiently rich in food resources so that their founders, while remaining hunter-gatherers, could free themselves from the harshness and constraints of itinerant life. These nomads, who had become sedentary, had been able to invent techniques for storing and preserving their wild foods (fish reserves, acorn or chestnut pits, grain silos) which allowed them to spend the winter without suffering from hunger.

One question remains… Why did these sedentary hunter-gatherers decide, around the middle of the tenth millennium BC, to cultivate cereals permanently and on a large scale? In reality, we still ignore it! The "agronomic trials" carried out 11,500 years earlier in Ohalo show that it was not for lack of knowledge: very attentive observers of nature, prehistoric men knew perfectly, and certainly for a very long time, the principles of the reproduction of the plants and animals.

The cultivation of cereals has gradually changed their initial "wild" characteristics. In the Near East, this slow process known as domestication took about a thousand years (this is the time after which archaeologists begin to be able to distinguish cultivated grains from their wild counterparts). Thus, to cite only this example, in engrains and wild starch plants, the axis of the ear fragmented spontaneously at maturity, which allowed the grains to fall on the ground where they would be able to germinate. However, what represented an advantage in nature constituted a major disadvantage for the first peasants: they risked seeing the grains which they had cultivated scattered on the ground just before the time decided for the harvest!

They then preferentially sowed the seeds from "non-breaking" ears, and this characteristic gradually spread in cultivated populations. Among the hypotheses put forward is that of climatic variations. Having become warmer and wetter in the Near East after the end of the Ice Age, the climate favored the spontaneous growth of many nutritious species (engrain, starch, barley, lentils, chickpeas, vetches, etc.). This new environment, as we have seen, made it possible to settle down. But 13,000 years ago, the region's climate deteriorated again, becoming colder and drier again (Younger Dryas period). As a result, wild food resources have become scarce, forcing certain human groups to become nomadic again while others have chosen to produce their own food.

Other researchers have especially seen in the birth of agriculture the only way, for the sedentary hunter-gatherers, to face a growing demography - and therefore to increased food needs - by avoiding "swarming" d 'part of the community. In fact, in the village, the living conditions were much less precarious than those of the nomads, which reduced mortality (especially infant) and favored the growth of the population. This demographic boom would also have resulted from the fact that sedentary mothers breastfeed their babies for much less time than nomadic women, which makes their pregnancies more frequent. Simple reasons of comfort were also invoked: tired of traveling long distances to bring food back to the village, the sedentary hunter-gatherers would have liked to have them on hand, in the immediate vicinity of their homes.

Let us cite one last explanation, of a different nature. This thesis suggests the emergence of a new conception of the world and of the place of man in nature. Around 10,000 BC. AD, Homo sapiens would have ceased to consider itself at the same level as plants and animals. He would have seen himself above them and, as a result, would have finally felt authorized to appropriate them, to dominate them ...

Ultimately, the birth of agriculture remains an enigma. Despite everything, it is likely that it did not obey a single causality but a combination of several factors, of a climatic, environmental, demographic, technical, cognitive or even cultural nature. In other words, to a chain of necessities and favorable conditions. A sequence that may have varied according to the different regions of the world where, without any link between them, other types of agriculture were born later.

From the Middle East where it first appeared, agriculture - and above all the cultivation of cereals - is slowly spreading throughout Europe. Around 6800 BC, "Neolithic migrants" began to leave their eastern lands and set out for our continent. They take with them the cereals, other plants (peas, lentils) and animals (goats, sheep, oxen and pigs) that they have domesticated. By following two distinct routes : one towards the West (Europe), the other towards the East (Asia).

Apart from the Fertile Crescent, we find "first peasants" in ten major areas of plant domestication, spread over the American and African continents, as well as in India, China and Papua New Guinea. Regarding cereals, we can cite corn, domesticated in Mexico 8,700 years ago, rice (China, between 8 and 10,000 years ago), millet (domesticated 6,000 years ago in China, 4,500 years ago in China). India and 3000 years in Sahelian Africa), sorghum (Sahelian Africa,

4000 years), quinoa (Andean highlands of South America, 3200 years) ...

Among them, one of the most fascinating is that of Pharaonic Egypt ...
The people of the Nile Delta and Valley began to cultivate cereals (wheat and barley) more than 6,000 years ago, taking advantage of the fertilizing floods of the nourishing river. This nascent agricultural activity reinforced and complicated the structure and hierarchy of early Egyptian society. Gradually, the small local chiefs saw their power asserting itself: it was up to them to ensure the fair distribution of agricultural land among the members of the village, to ensure the protection of the latter and their property. , organize the storage of harvest surpluses and their redistribution in the event of scarcity. Some of these men of power succeeded in gaining the ascendancy over their counterparts, in unifying villages and territories and in constituting, in the fourth millennium BC, a centralized state dominated by the divine figure of the Pharaoh. A state whose rigorous organization and management have made it possible to create and maintain large-scale hydraulic installations (flooding basins, dikes, irrigation canals, etc.). This efficient agriculture, capable in a normal year of feeding several million subjects, was one of the finest achievements of Pharaonic civilization.

Cereals - wheat and barley - were the very staple food of the Egyptians. It is moreover to the people of the Nile that, most often, the invention of bread is attributed to the fifth millennium BC. An invention whose genesis, unknown, perhaps owes much to chance ... One version says that one day, a piece of dough intended to be baked to make pancakes would have been forgotten; yeasts would have been deposited there and would have made this dough ferment and rise. What we are sure is that the Egyptians made wheat loaves of very varied shapes (some were filled with figs or dates). And that they used barley to make beer… "I paid them in beer and bread, and I made them swear they were satisfied," Priest and Judge Kai said of the workers who were building. his tomb and had participated in the construction of the pyramids. In this regard, there is another relationship between these grandiose monuments and wheat… The word pyramid comes from the Greek puros which means wheat (and not fire, which is said to be pure). Puros gave puramis, which referred to a specially shaped wheat and honey cake. The pyramids having the same shape as this pastry, they simply borrowed its name.

Adorning the tombs of dignitaries in ancient Egypt, magnificent paintings and engravings represent scenes of plowing, sowing, harvesting ... By their presence on the stone, these sequences of peasant life were supposed to continue in Au beyond and thus ensure the food of the deceased. Their observation tells us about the agricultural practices of the Pharaonic civilization ...

During sowing, the grains are thrown on the fly on land still saturated with the water of the river and which an area, pulled by men, has previously split. Another scene represents the harvest, carried out with a sickle, of wheat the size of which is much larger than those of today; gleaners follow the harvesters to retrieve the ears and grains that have fallen to the ground. The fresco also shows the cutting operation: cows trample with their hooves the sheaves placed on the threshing floor, which makes it possible to separate the kernels from the ear and free them of their husks.

Egyptian tombs have also been unearthed numerous statuettes (servants crushing cereal grains to make flour or making beer), models (granaries for storing crops), reproductions of food and drink. Whether drawn, painted, sculpted or engraved, all these representations could acquire, thanks to the prayers pronounced by the living, a material reality whose purpose was, again, to nourish the deceased in the Hereafter. The excavations also yielded real remains of grains and ears as well as the remains of products made from cereals: porridge, pancakes, breads, beer.

Cereals and gods

The vital place of cereals in the diet of many peoples could only endow these plants with a highly sacred character and, often, a divine status. To illustrate this, let's go back to the banks of the Nile… To the river itself, and to the cereals it cultivates, the ancient Egyptians associated many gods and protective geniuses. These deities varied according to the times and places, but among the most cited were Nepri (who was the personification of the grain of wheat) and Renenoutet, his mother. On the first day of the harvest, the peasants made offerings of grain and braided ears to this goddess; this one was often represented under the features of a cobra, snake which feeds on small rodents… devourers of cereals.

However, the most important of the deities associated with cereals was Osiris, one of the major gods of the Egyptian pantheon. It was he who created wheat and invented agriculture, and who gave it to men. The Egyptian tombs have yielded many "vegetating Osiris": these are statuettes of the god represented in a supine position, modeled from silt, water and barley grains. Before placing them in the tomb, these figurines were watered so that the grains germinate (the choice of barley was justified by its faster germination and growth than those of wheat). The rebirth of the cereal grain after it was buried (its death) symbolized the resurrection of Osiris.

The myth is known: the god was assassinated by Seth, his younger brother; the latter dismembered the body of his victim into fourteen pieces which he dispersed; Isis, the sister and wife of Osiris, managed to find and then bring together the scattered members, which allowed the deceased to come back to life. The resurrection of Osiris, symbolized by the germination of the barley grains of the statuettes, was to by "magic contagion" allow that of the mummy placed in the tomb.

The peoples of SORGHUM

Will the climate resilience of African agriculture depend on the cultivation of millet and sorghum? Produced mainly in Africa, these two cereals have record capacities of resistance to thermal stress. The data is available in the UN multi-agency report on the state of the climate in Africa, published on October 26, 2020.

One of the aspects highlighted by the UN multi-agency report on the state of the climate in Africa is the capacity for climate resilience hor s par of millet and sorghum crops. Millet, for example, is capable of flowering up to a temperature of 42 ° C. An exceptional performance, which allows these two cereals to develop in arid regions with water requirements of 250 mm / year, or less than half the volume required by rice, 750 mm per year.

In a scenario where global warming is set to worsen in Africa, UN experts estimate that the average yield should decrease by 5% for millet and 8% for sorghum by mid-century against larger drops of 12% and 21% respectively for rice and wheat. Africa, which provides more than half of millet production, will therefore be able to maintain its rank.

"Thus, in agriculture, it is possible to change the sowing dates (incremental). Varieties and practices can also be changed, for example by introducing agroecology and (systemic) agroforestry. Finally, redesigning agricultural systems, modifying and relocating production is a transformational adaptation. "

Climate change has a growing impact on the African continent

Millet and sorghum may well be resistant to global warming, but they alone cannot guarantee the economic contributions of agriculture and the food security of the continent. This is because cash and staple crops such as rice and wheat will be hit hard, with yield losses by 2050 of 1 2% and 21%, respectively, under a scenario predicting an increase. global temperatures of 1 ° C to 4 ° C compared to pre-industrial levels.

"This warming is comparable to that of most other continents, and therefore a little faster than the average temperature on the earth's surface. The latest ten-year forecasts, covering the five-year period from 2020 to 2024, show continued warming and decrease in rainfall, especially in North and Southern Africa, as well as increased rainfall in the Sahel "we read. in the report.

There is still a positive note in this report, namely the increasingly important involvement of African countries in the fight against climate change. The World Meteorological Organization (WMO) reveals that more than 90% of African countries have ratified the Paris Agreement and

several have committed to switch to green energy in a relatively short period of time. Renewable energies and agriculture, for example, are a priority in more than 70% of African Nationally Determined Contributions (NDCs), enacted under the Paris Agreement.

And globally, both the NAS and the World Bank and many other sources expect climate change to reduce agricultural productivity overall, due to more frequent droughts and heat waves, pests. more abundant, etc.. And the more intense the warming, the more severe the consequences.

Despite all their precautions, they then write: "The deterioration of the water quality or the nutritional value of a certain number of agricultural products will potentially have impacts on health. More broadly, a changing climate will affect the pathways of microbial contamination, diseases transmitted by vectors or rodents, allergies, infectious diseases and mental health. "

Civilisation of wheat : The Occident

A flagship production of global food security, wheat has always been at the heart of history and power games. More discreet than oil, less brilliant than gold and in no way controversial like uranium, it is not a commodity like any other. It is a vital product, the culture of which has quite simply transformed the physical, demographic and political landscape of the planet. Without wheat, there is no security. For a state, owning it means controlling its stability and having a major strategic asset for its international influence if it exports part of its crops. Conversely, running out of wheat to meet domestic needs is already revealing a weakness and revealing a point of high vulnerability.

These contemporary observations are also very old. Proposing a geopolitics of wheat without looking at the long periods of history is not possible. There is no question here of going through several millennia of civilization during which wheat appears as a central element in the daily lives of populations. The emphasis, on the other hand, is on Antiquity, the French Revolution and the wars of the twentieth century. Throughout these historical periods, wheat and, more broadly, food security appear as major determinants of the course of events, strategies or conflicts.

Wheat, a central issue since Antiquity

During Antiquity, wheat occupied a major place in the diet of the ancient Greeks. In Attica, the territory in which Athens is located - following the process of the formation of the City and therefore the regrouping of men - cereal production quickly turns out to be insufficient to feed a population of around 250,000. inhabitants at its peak under Pericles, in the 5th century BC The wars, numerous and regular in ancient Greece, did not spare agriculture: degraded soils, mobilized labor and stolen means of traction, etc.

The insecurity, which accompanies any situation of war in a territory, also makes farmers reluctant to sow in the face of the uncertainty of future harvests. Just like today, where wars are raging, the conditions for agricultural activity and food security are deteriorating. To respond to its demographic and economic development,

but also to cope with climatic constraints, Athens must compensate for its food deficit through trade. The supply of wheat is indeed necessary to feed the workers and bring stability to the City that empty bellies could compromise. It must therefore be organized strategically. This paradigm has never wavered since: wheat and urbanization are intimately linked. And when the food security of the populations of a city depends on the outside, it is necessary to build a commercial device and to ensure its reliability in the long term.

The geographical disparities between the different regions of the Mediterranean largely explain the dynamics of a trade between areas where local production exceeds local needs and others where, conversely, demand is not satisfied. The geopolitical importance of the port of Piraeus at this time must be understood in the light of these realities: it is then the obligatory point of passage for the grains circulating towards Athens as well as the nerve center of Mediterranean trade. To bring supply closer to demand, navigation is essential. Athenian maritime power makes it possible to orchestrate and control the flow of goods, through the establishment of a logistics chain linking the Mediterranean shores. This strength also gives it the ability to fight against piracy and enemies, and of course to conquer distant territories.

In this perspective, the strategies put in place to ensure the proper functioning of the maritime routes between the Peloponnese and the Black Sea were carefully thought out. If the wheats of Sicily, eastern Thrace, Syria and, above all, Egypt nourish Athens, those of Pont-Euxin, the old name of the Black Sea, were the most prized. Colonized from the 7th century BC, the shores of the Black Sea will gradually make this space a real lake under Greek control. Many cities prosper thanks to trade towards the southern and warm routes of the Mediterranean. Wood, leathers but above all and above all wheat left for Greece from the lands of present-day Crimea, which quickly became the granary of Athens. Pisistratus, who seized power in the middle of the 6th century BC and became the first tyrant of Athens, was also the instigator of an ambitious trade policy in the Aegean Sea and in the area of the straits, making it possible to trade Athenian ceramics with wheat from the North of the Black Sea.

Athenian military colonies were then established on the Hellespont, the area of the straits where a special guard was set up. Subsequently, Pericles consolidates the device. The safety of navigation becomes fundamental on these lines, which are now vital for the Athenian populations and the economy of the City.

A series of diplomatic alliances and treaties enabled Athens to ensure long-term relations with the cities of Pont-Euxin and the straits. Sestos, located at the narrowest point of the Dardanelles, was then considered to be the "wheat chest" of Piraeus. Athens shapes its foreign policy according to its economic interests. The constitution of the League of Delos, from 478 BC, falls within this perspective. The thalassocracy - which characterizes a power based largely on the domination of the seas - is not only the expression of a maritime military power aimed at fighting against the Persians; it is also the tool allowing a dynamic and regular trade in the Aegean Sea so that the products circulate correctly, and in a mutually profitable relationship, between the cities or from the Black Sea.

For Athens and its leaders, it is essential to protect these sea routes in order to secure the food supply. Moreover, only the wheat trade was then subject to rigorous regulation. Legislation is put in place to administer wheat imports and circulation. It is forbidden for any person domiciled in Athens - citizen or metic - to lend money in favor of a shipment of wheat destined for a city other than Athens. Wheat merchants (sitopoloi) were not allowed to buy more than 50 measures of wheat at a time from importers, a procedure which was scrupulously watched by the special magistrates for the wheat trade (sitophylacs).

For planning reasons, wheat must be unloaded in Piraeus. Two thirds of the loads arriving at the port are automatically destined for

Athens, the remainder being stored on site. Some silos are up to thirty meters long and ten meters wide, like those in the neighboring city of Eleusis. From there spread throughout Greece the esoteric worship of Demeter, goddess of agriculture, known under the name of the "Eleusinian mysteries". At the same time, the practice of sitonia is taking place. It allows donors to sell wheat to the City at low prices so that it can distribute it to the population, especially in times of scarcity. These citizens were then rewarded for their generosity by an honorary decree. Owning wheat therefore confers power and prestige.

The Athenian Assembly can also launch loans by subscription so that funds can be used to purchase wheat when public finances are degraded or in times of scarcity (sitodeia). This process developed strongly from the 3rd and 2nd centuries BC Buyers of wheat (the sitonai) were then sent to the Mediterranean to acquire this vital commodity under the best economic conditions, from the purchase price to transport costs, proof of this is that it was already necessary to integrate all costs, from the edge of the fields to the streets of Athens.

Locally, the wheat deficit justifies the deployment of military resources. Most of the colonies of Athens are moreover located in agricultural regions rich in wheat or likely to become so. Alcibiades, statesman and Athenian general, a great supporter of an expansionist policy, set out to conquer Sicily in 415 BC with the support of 100 vessels with the declared aim of seizing the wheat from the largest island in the Mediterranean, which is also one of the largest granaries in the region during the Ancient period. Its objective is to gain a strategic advantage vis-à-vis rival city Sparta. The Greek colonization of eastern Sicily served as a platform to ship grain to Athens, especially from Syracuse.

Wheat in the history of France

Further in time, wheat is also at the forefront of French history. The tithe system, an ancient religious tax, developed significantly during the Middle Ages. This involves taking about a tenth of agricultural harvests - or even more in certain regions - to make them available to the Church in order to be able in particular to anticipate possible years of famine. If wine, animals or even flax are concerned, it is above all wheat which is mainly taken, hence the term "big tithe" to categorize it among other productions.

The peasants do not always see this tax favorably, since it affects their main means of subsistence and because it is sometimes the object of misappropriation, thus removing the tithe from its primary function. Indeed, greed and corruption are not recent phenomena. But its obligatory nature, in a socio-political context in which the Church is dominant, gives tithing a special place. By delivering his wheat to the parish or the bishopric, the peasant hopes to be able to come closer to God. The tithe therefore gradually contributes to creating a collective identity of solidarity in this rural France.

Depending on the filling rate of the tithe barns, an overview of the agricultural situation (harvests, yields) is also possible. Old tax which is added to so many others during the Middle Ages and the modern period, it is paid until 1789, year of all the ruptures for the kingdom of France.

At the end of the 17th century, according to the work of Vauban, bread still represented two-thirds of the household budget. In the 18th century, the balance of power between a population whose demands were progressing and a monarchy whose power was eroding crystallized around many points of economic friction, including that of access to bread. Turgot's reforms, inspired by physiocratic theories and the works of Pierre le Pesant de Boisguibert, an economist of the Kingdom, and the "flour war" which ensued, bear witness to this. The people, in particular that of peasant France, are mobilizing against the excesses of economic liberalism arousing many fears. In 1707, Boisguibert published a work entitled Treaty on Nature, Culture, Trade and the Interest of Grains, in which he advocated the importance of agricultural production in examining

the wealth of a country. He also promotes the freedom of the grain trade for better economic development of trade. This theory was subsequently taken up by the Physiocrats and then by Turgot, a leading man as controller general of finances to King Louis XVI.

The implementation of these policies is one of the causes of the outbreak of the "flour war". In April and May 1775, several regions of the Kingdom, mainly in the North, experienced riots following the soaring price of grain and therefore of bread, resulting in particular from the Edict of Turgot of September 13, 1774, which established a liberalization of grain trade. However, this decision comes after two years of poor harvest and is not tolerated by a population who considers that the king must protect his subjects and guarantee them a supply of basic products on a regular basis and at affordable prices. The people believe that "grabbers", anxious to get rich, seek to control the grains and their distribution in this context of scarcity.

This situation leads to an about-face of power, which finally reestablishes price controls. This agitated episode echoes the work of the economist of the Kingdom of Naples, Ferdinando Galiani, who in 1770 underlined this timeless truth on the subject: "Wheat can be regarded as a production of the soil, and in this view, it belongs to the trade and economic legislation. Then it must be regarded as the material of first necessity and the first care in the civil order of the societies, and from this point of view, it belongs to the policy and the reason of state "

The "flour war" heralded the revolutionary uprisings at the end of the century. While there is no question here of denying the role of the bourgeoisie in the French Revolution of 1789, numerous works by historians have also underlined the plural character of this French revolt. At the same time, there was a peasant revolution, which had its own dynamics. The very strong concerns about rising wheat prices then helped catalyze the anger. Rural France is therefore not a spectator of the revolution; on the contrary, it is at the heart of dramas and battles. Shortly after, the economic debates in France on the freedom of trade in wheat remained tense, especially during the two subsistence crises of 1811-1812 and then of 1816-1817, which also revealed deep spatial tensions within the country, with the political primacy given to the Parisian consumption center.

From the second half of the 19th century to the eve of the First World War, agriculture remained in France the leading economic sector and the leading provider of jobs - around 40% of the working population. It even constitutes the social ideal of the Third Republic, leading the State to endow it with a full-fledged ministry from 1881. But World War I devastated the lands of Europe. In France, the agricultural consequences of the conflict are extremely heavy. When the fighting broke out in August 1914, the harvests were not completed and the peasants had to abandon their harvest to go to the front. Almost 3.7 million of them left their fields between 1914 and 1918, or two thirds of the French agricultural force. More than a million of them will perish or return too severely injured to carry out agricultural physical activity thereafter. The labor shortage is coupled with a sharp drop in the means of traction, at the time horses, and the availability of inputs (potassium fertilizers, nitrogen, etc.), then used in the manufacture of explosives. . Already in deficit, cereal production in France is collapsing. The soils, occupied by the troops and laminated by the war, are no longer cultivated. In 1918, the cereal areas decreased by a third compared to 1914.

Yields simultaneously sank and wheat production reached, at the end of the war, only 60% of what it was at the beginning. fights. In this context, the shortage of bread looms, while the last great famine in France dates back to 1847. Between 1914 and 1920, the price of wheat tripled. In 1917, a ration card was introduced. Imports are increasing, especially from the colonies, and especially from Algeria. From 1915 to 1920, more than 2 million tons of wheat were imported, a quantity three times greater than before the war. In France, to cover national needs, the economic results are disastrous since the imbalance of the trade balance is growing. Despite the recovery of Alsace-Moselle, which allows the country to enrich

itself with new wheat lands, France's food security depends on foreign or colonial supplies.

The great producing powers, far from a European continent on fire and blood, seize the opportunity: the United States, Canada, Argentina and Australia are positioning themselves. The British, French and Italian allies are pooling their logistical resources and their boats to ensure these distant supplies. While the Méline laws, at the end of the 19th century, had been introduced to protect cereal farming in France and preserve it from international competition, the agricultural force, given the ravages of war, was really undermined at the time of the signing of the Treaty of Versailles. The role of the North African colonies will also prove to be invaluable for the importation of wheat into France between the wars and until the aftermath of the Second World War.

In France, following the international economic crisis of 1929, wheat was subject to a veritable legal proliferation: more than a hundred laws, decrees and regulations were taken at the beginning of the 1930s. Shortly after, a series of good harvests allow stocks to be replenished, even to the point of accumulating them beyond the country's logistical capacities - insufficient storage centers, infrastructural inability to export - and causing prices to collapse. But with the return of the fighting in Europe, which affected France from 1940, the acuteness of the food stakes was total in the country.

Episodes of bread shortage traumatize the authorities and populations, who still consumed an average of 135 kilograms per year before the war. The State then tried to rely on the National Interprofessional Cereals Office (ONIC), successor in 1940 of the National Interprofessional Wheat Office (ONIB) created in 1936 by the Popular Front so that bread was distributed under better conditions. . It was not until February 1949 that the rationing of bread was lifted and the beginning of the 1970s so that national cereal needs were met without recourse to external purchases. It has therefore hardly been less than half a century since the French are no longer at the mercy of world wheat - and therefore of abroad - to consume it daily.

At the heart of the dynamics of the 20th century

At the start of the 20th century, the ancient world, characterized by a monopoly of power by European nations, confirmed its decline, both geostrategically and in terms of wheat production and trade. This state of affairs is the result of major trends, at work since the 19th century, in which the United States is gradually establishing itself as the conductor. Wheats from the United States, Argentina and Canada arrive on European markets, benefiting from the development and low cost of maritime transport, but above all from demand.

The rice civilization

Thousands of years ago, the people of Asia settled in the deltas and domesticated rice. The origin of the genus Oryza is located in Eurasia 50 thousand years ago, but its ancestor came from Africa: the weak divergences imply a recent transport (human journeys); the strongest divergences reflect ancient transports linked to animal migrations and then the paleodistribution becomes coherent. Animals carry seeds, defecate and trample the soil: three contributing factors! Then, domestication prolonged the movements.

Productivity favored demographic growth and allowed the development of civilizations as well as cooperation. The unifying force of rice is particularly visible in the Mekong Delta in southern Vietnam. Water needs have shaped landscapes and culture.

The curves of the rice terraces, which seem to extend to infinity, enhance the beauty of many Asian landscapes, so much so that the terraces of Banaue, in the Philippines, are a UNESCO World Cultural Heritage site.

Among the poaceae, rice occupies, with wheat, the most important place for human consumption. Archaeological traces of the use of rice date back to China 9,000 years ago and can be found in Korea, India, Thailand, etc.

In the 20th century, Shigemoto Kato described the existence of two subspecies: Oryza sativa japonica and Oryza sativa indica, which the Chinese recognized in the types "Keng" and "Hsien". Roland Portères will recognize for Oryza glaberrima an independent African origin. So we have, with three main types of rice, a fabulous richness.

Rice, its origin and its evolution

The rice genome has been sequenced. DNA analysis has made it possible to establish the phylogenetic tree of rice from its common ancestor (see image below), with an evolutionary scenario that takes into account plate tectonics and changes in the environment. Southeast Asia is a refuge for Oryza species adapted to humid forests; Central Asia, drier, is one for light rices, particularly the annual coarse-grained forms

In all these countries there is a real veneration of rice, often considered as a supernatural force whose good graces must be won. One example among many

others: in Northern Laos, rice has a soul; it is a question of pleasing it, of keeping it in the grain. Are these traditional rice fields eternal? After a stability that lasted several centuries, their regression, in some countries, may be linked to political events which ruin favorable frameworks (Sri Lanka, Angkor, Assam) or to modernization, as in Japan, followed at a distance by South Korea and Taiwan, where rice fields are retreating in front of urban and industrial expansion. It is then the end of the conquering rice. Will countries devoted to rice cultivation, like Japan, be able to switch painlessly from a traditional economy to a modern economy?

Rice is considered in Asia as a gift from the gods to men: the Vedas (sacred texts of Hinduism) designate it as "the Son of heaven who never dies. Rice is omnipresent in Hindu ceremonies and rituals, especially in the form of an offering to the deities. When the young wife enters her husband's house for the first time, the threshold of the house is covered with grains of rice heralding the happiness to come. Another rite consists, between ten and thirty-one days after a death, in offering the deceased rice balls to feed him; this gives him the status of pitri, that is to say ancestor benevolent towards the members of the family. The importance of rice in the diet also explains the breadth (four days) and exuberance with which Pongal, the annual rice harvest festival, is celebrated.

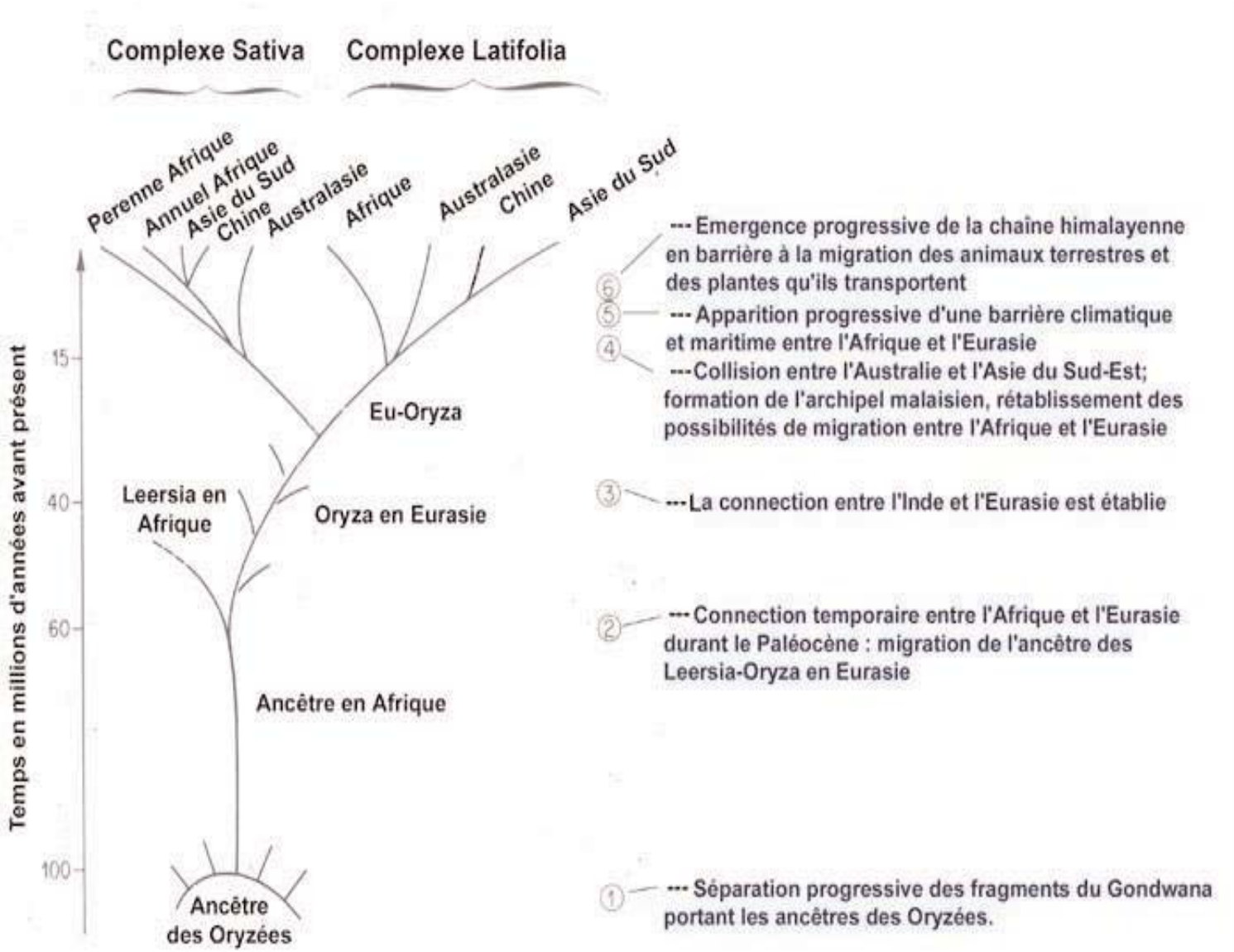

Complexe Sativa
Complexe Latifolia
Perenne Afrique
Annuel Afrique
Asie du Sud
Chine
Australasie
Afrique
Australasie
Chine
Asie du Sud
Temps en millions d'années avant présent
15
40
60
100
Eu-Oryza
Leersia en Afrique
Oryza en Eurasie
Ancêtre en Afrique
Ancêtre des Oryzées
6 --- Emergence progressive de la chaine himalayenne en barrière à la migration des animaux terrestres et des plantes qu'ils transportent
5 --- Apparition progressive d'une barrière climatique et maritime entre l'Afrique et l'Eurasie
4 ---Collision entre l'Australie et l'Asie du Sud-Est; formation de l'archipel malaisien, rétablissement des possibilités de migration entre l'Afrique et l'Eurasie
3 ---La connection entre l'Inde et l'Eurasie est établie
2 --- Connection temporaire entre l'Afrique et l'Eurasie durant le Paléocène : migration de l'ancêtre des Leersia-Oryza en Eurasie
1 --- Séparation progressive des fragments du Gondwana portant les ancêtres des Oryzées.

Fig. 1: Origine eurasienne d'Oryza à partir d'un ancêtre africain

The civilisation of maize

In pre-Columbian America, another cereal - corn - also contributed to the development of great civilizations. Maize comes from the cultivation of teosinte, a modest plant whose ear, in the wild state, has only six or seven small kernels. Consumed by Paleolithic hunter-gatherers, teosinte began to be cultivated almost 9,000 years ago in a high valley in Mexico. From this cradle, the ancestors of our current corn first spread to all of Mesoamerica (Mexico, Yucatan, Caribbean ...) then to the south of the continent: 7000 years ago, corn was produced in certain valleys of the Peruvian altiplano located at an altitude of 2600 m.

Six millennia later, the Amerindians succeeded in acclimating corn in the temperate regions of the north of the United States and Canada. The cultivation of corn favored the emergence and development of great conquering and building empires, the best known being the Mayas, the Aztecs and the Incas. In addition to its nutritional benefits, corn has a double advantage. In the first place, this cereal grows quickly, which leaves the peasants time for other activities such as wars of conquest and the building of powerful cities with impressive monuments. In addition, in a normal year, the high productivity of maize makes it possible to generate significant surpluses which, exchanged for other goods, constitute a source of wealth.

Maize is widely cultivated for its starch-rich grains, for daily consumption by people and as a fodder for animals. The staple food in Central America, corn also has a sacred dimension for the civilizations that populate the American subcontinents, constituting a link between men and the gods: corn has, in many pre-Columbian cultures, a double dimension. of divine gift allowing the subsistence of the men and of offering of the men to the divinities. Corn is at the heart of cosmogony, that is to say of the representation that populations have of the creation and organization of the universe.

This is the case with the Mayas, a Mesoamerican civilization located on the Yucatan peninsula (currently corresponding to southern Mexico, Guatemala, Honduras, Belize and El Salvador). Between 600 BC AD and around 1000 AD. AD, the Mayan culture develops in city-states, such as Copán, Tikal, Palenque and Chichén Itzá around the cultivation of corn. The word "maya" would mean "corn"; cereal which therefore holds a primordial place in mythologies and in everyday life. Indeed, the Mayans identified themselves as "men of corn" and practiced, using compression boards, cranial

deformation from an early age, by parallelism with the shape of an ear of corn. The Aztecs or Mexicas politically succeeded the Mayas from the 13th century until the year 1521. They deified corn under the guise of Chicomecóatl, goddess of subsistence and vegetation, in particular corn, and, by extension, goddess of fertility. It is also called Xilonen, ie "the hairy", thus evoking the silks of young corn cobs. The cult of Chicomecóatl was focused on the month of September called huei tozoztli (prolonged fasting). The altars of the houses were then adorned with corn plants, and in the temples the seeds were blessed. Sacrifices were associated with the cult aimed at feeding the goddess who had herself provided the subsistence of human communities. On the other hand, the Mexicas worshiped a deity by stage of maturity of corn (the goddess Ilamatecuhtli symbolizing ripe corn, for example, while Chicomecoatl was associated with young corn), thus recalling, in addition to the daily consumption of this cereal, the importance of the cycle of its culture in the Aztec world.

In South America too, in the Andean regions influenced by the Mayan culture (Ecuador, Peru, Bolivia, Venezuela, and Colombia), this cereal holds a preponderant place in daily life and in beliefs. Thus, chicha, a drink made from fermented corn, was consumed by shaman priests as part of their spiritual activities.
Today the Mayan culture is still very present in Yucatan and corn is still the staple of the diet in Central America. In addition, if corn is closely related to the representation of the universe and the gods in Central and South America, on most other continents the cultivation of cereals is reflected in the daily life of a community, where the agrarian calendar serves as a model for social events and rites.

Among the peoples of Central America (Mayas, Aztecs, etc.) as among the Incas of the Andes and certain Indian tribes in the north of the continent, corn represented much more than a food resource. This cereal had acquired the status of a sacred plant and was present in many myths. The Navajo Indians believed that the corn had been brought to them from heaven by a turkey while the Creeks claimed that the plant had reached them in the ear of a crow. The Mayan aristocrats deformed the skulls of their infants to take the oblong shape of a… ear of corn. The "men of corn" (this is the meaning of the Mayan word) saw in this very vertical cereal the union of the ascending force of fire and the descending energy of rain. According to the Popol Vuh, the sacred book of the Mayan people, it is the corn which allowed the creation of the human species ... At first, the gods tried to fashion men from clay, wood and many other materials. All these attempts turned out to be unsuccessful… until they came up with the idea of kneading them with cornmeal. Another myth tells how humans discovered corn ... They learned from the fox that the ants saw this cereal hidden under a mountain. They then ask Chac, the rain god, to help them. What he does by sending thunderbolts through the mountain. Part of the corn turns black because of the smoke released, another part takes on the red color of fire; corn that has received only a small amount of heat turns yellow, while corn that has not been hit by the lightning remains white.

Why did Egypt and Mesopotamia stand out from the rest of the world by entering history first? Why did civilizations spread so effectively along the Mediterranean? Why did Europe conquer the "New World" and not the other way around? What explains the ascendancy taken by Chinese and Indian civilizations in Asia? Why did Australia and much of sub-Saharan Africa have a more limited historical presence in written and monumental remains?
World history and climate history: what is the link?
To answer these questions, one must understand the logic underlying the plot of observed history. Has the evolution of humanity since the Neolithic followed random processes, or is there an underlying determinism explaining the observed diversity? This is a crucial question, because the current distribution of wealth in the world is the result of this long historical evolution.

Two facts suggest that the climate could be an essential explanatory factor:

* the Neolithic revolution, a prelude to entering history, was made possible thanks to the end of the last glaciation: the passage from a cold and dry environment to a hot and humid environment was essential to initiate the practice of farming.

* before the industrial revolution in the 19th century, the economy of societies was always dominated by the agricultural sector, which is highly dependent on the climate;

The existence of written or monumental vestiges makes it possible to list in a relatively objective way the main historical civilizations of the world. Moreover, in this part, we are only concerned with civilizations that have emerged independently: the rise of these civilizations cannot therefore be explained by the heritage of other civilizations.

The Eight Autonomous Civilizations of History

-The Sumerian civilization in Mesopotamia, born around 3500 BC. J.-C.
-The Egyptian civilization, born at about the same time.
-The Sabaean civilization straddling present-day Yemen and Ethiopia, which finds its roots around 2500 BC. J.-C.
-The Indus civilization in present-day Pakistan, which took off around 2300 BC. J.-C.
-The Chinese civilization in the Yellow River Valley (modern northern China), which begins to emerge around 2200 BC. J.-C.
-The Indian civilization in the plain of the Ganges at the foot of the Himalayas, which takes shape little by little from 1700 BC. JC to 500 BC. J.-C.
-The Olmec civilization in the south of present-day Mexico, which seems to emerge around 1200 BC. J.-C.
-The Caral civilization on the Peruvian Pacific coast, which may have emerged as early as 3000 BC. J.-C.

Between the year 12,500 and the year 7,500 BC. BC, small human communities begin to group together in permanent villages. Then they develop agriculture in addition to hunting, fishing and gathering. They then practice animal husbandry and finally cultivate the arts of fire, in particular pottery and bronze metallurgy.

Men cease to be only predators who draw their sustenance from nature. They become producers who renew what they consume (seeds, game) through sowing and breeding. This change is observed in the Middle East and almost simultaneously in northern China, the Sahara and the Andes.

First villages
Before this change occurred, the first men lived in rock shelters and derived their subsistence from hunting, fishing and gathering... Thus lived, for example, the men who decorated the caves of Lascaux and Altamira (16,000 BC).

Nomadic and few in number (a few hundred thousand in all and for all), they roamed the earth in search of food. They enjoyed without too much harm the fruits of the Earth, especially since after the last ice age, which dates back to 16,000 years BC. AD, climate warming had favored the proliferation of game, cereals (wheat and barley) and legumes (peas or lentils) in temperate zones.

Occupy the territory

The village preceded agriculture: nearly 12,000 years ago, inhabitants of the Levant gave up the uncomfortable huts of hunter-gatherers to invest in more solid dwellings. No more temporary and unsanitary!

The beginnings are humble, we are content with mud or stone huts, sometimes half-buried, built near the resources essential to the life of a small group: rivers of course, but also hunting area.

Over the centuries, semi-nomadic life became completely sedentary and to avoid having to travel too far to pick or hunt food, seedlings were developed around dwellings and animals were domesticated (after the dog, hunting companion is the goat, which gives its milk and its meat).

The village then takes shape while, faced with the accumulation of goods, the spirit of ownership develops, making each stranger a potential enemy. Having understood that unity is strength, we protect ourselves by grouping together habitats. The village becomes not only a place of community life but also of defense for the fifteen families who have settled there. Finally quiet? Not quite...

Everything changes around 12,500 BC. AD.

The change is so significant that prehistorians refer to it as the "Neolithic revolution".

First sowing

Agriculture was not strictly speaking invented. Hunter-gatherers have always known that by dropping a seed on the ground, it would give rise to a new plant. At the beginning of humanity, getting enough resources from simple picking, they did not bother to methodically exploit this observation.

Then, as we have seen, men began to group together in small villages without ceasing to practice hunting and gathering, simply because community life brought them more comfort and security than solitary life. The improvement of living conditions then favored the growth of the population.

Around the villages, it has become increasingly difficult to stick to simple picking. This is how we began to encourage the growth of plants around the houses. Then, we got down to hoeing and upkeep of the plots to improve their yield. With the birth of agriculture, our ancestor will slowly upset his relationship with nature, no longer content to collect the riches of the surrounding world, by hunting, fishing and gathering, but choosing to domesticate it. He thus began to select formerly wild plants and animals to better control his supply. After the dog, pet and hunting companion, the first domestic animal is the goat.

The Sumerian, Egyptian, Sabaean and Indus Civilizations

The first four practiced the cultivation of wheat, and therefore appear as the heirs of the Fertile Crescent in the Near East: it is there that the first domestications of plants in the world, in particular wheat, were carried out. The Middle East was covered at that time with grasses (cereals) and it was calculated that a person could harvest enough wild einkorn in two weeks to feed a family of four for a year.
In the Near East, in the Jordan region, some communities take advantage of this abundant food at hand to live with several families in a permanent village rather than constantly moving and sleeping in makeshift shelters. They choose to live in groups but without changing anything in their hunter-gatherer practice. These villages mark the beginning of a pivotal period called Mesolithic (from the Greek word mesos which means middle).

Egypt and Mesopotamia are also precursors to all subsequent civilizations that will emerge from their contact, step by step: Hittites in Anatolia, Minoans in Crete, Israelis and Phoenicians in the Levant, Carthaginians, Romans and Persians. On the side of the Nile, a large part of the Egyptian gods take on the appearance of wild animals. They testify to the mixture of fear and admiration that the inhabitants feel for Nature.

In the Middle East, artificial waterways are appearing thanks to perfect control of irrigation which multiplies the cultivated areas to the detriment of the region's forests.

These will also suffer from the increase in population and its needs in terms of construction, metallurgy and heating, to the point of completely disappearing. What remains, in Iraq, of the Fertile Crescent of Antiquity?

To imagine its past splendor, one can dream in front of the "mountain houses" that are the ziggurats. They are an edifying reminder of the place, in these societies, of religion, one of the primary objectives of which was then to conciliate the terrifying forces of nature. The great myths are always there to remind us of this which, like that of the deluge, seek to explain the anger of the Earth.

The oldest written myth, the epic of Gilgamesh, already shows that its authors are aware that the retreat of forests leads to the aridification of entire regions. It also raises the possibility of destruction of humanity by a geological event, the Flood, seen as a divine punishment: the gods wish to finish with humans because they find them too noisy.

The peasant puts his skill at the service of the development of tools enabling him to work the land and its productions. He grinds the grains in mortars or in millstones which make him discover the virtues of polishing the stone. He developed basketry, ceramics and pottery.

It was in Anatolia (now Turkey) that copper was first used to make small objects or jewelry. But quickly, in the 5th millennium in Mesopotamia (current Iraq), metalworking enabled humanity to take a leap forward: by perfecting the ovens, craftsmen were able to develop larger and more solid instruments. Innovation is particularly consolidating carpentry, which is seeing its tools gain in precision. From this period (4000 BC) the plow was born, which made it possible to dig furrows in the ground in order to sow the seeds.

In Egypt, on the soils made soft by the floods of the Nile, the peasants soon used an improved plough, with a moldboard that threw the earth to the side. It is a sketch of the plow.

The discovery of the alloy technique, 5,000 years ago, enabled the inhabitants of Mesopotamia to produce tools in bronze, a mixture of copper and tin, which were more resistant and easier to work with. With the arrival of iron, developed by the Hittites around 1500 BC. J.-C., the means of traction and clearing still gain in solidity.

Relatively widespread, iron became an essential component of the agricultural world to which it provided robust and ultimately fairly inexpensive tools: hoe, spade, pickaxe... The Fertile Crescent, from Mesopotamia to Egypt, benefited greatly from it.

Are men benefiting from this revolution? Certainly, they multiply thanks to a more regular diet and better living conditions induced by a sedentary lifestyle. Demography is racing towards the rise of populations who are increasingly seeking to regroup for the sake of security; thus will be born the City-States.

"History begins in Sumer"

Located in the south of present-day Iraq, Sumer is a region of ancient Mesopotamia. The Fertile Crescent, this region of the Middle East, very sunny and lacking in rain, owes its name to the fact that it is crossed by two great rivers, the Tigris and the Euphrates. They attracted many human communities very early on and favored the development of agriculture.
In this now largely desert region that stretches from Egypt to Mesopotamia (present-day Iraq) cities, agriculture and writing were born.

Ourouk, the first city-state
Around 3300 BC. J.-C., occurs the urban revolution with the appearance, in the area of Sumer, of many cities with a hierarchical social organization, dominated by a king-priest. These communities practice the worship of the goddess of fertility.

One of the most prestigious of these city-states is Ourouk (in English Uruk, Erek in the Bible, today Warka). Populated at its peak by tens of thousands, it spawned the epic legend of the hero-king Gilgamesh.

Ourouk is also at the origin of the first writing in human history. These are signs engraved with the tip of a reed on moist clay tablets which are then dried in the sun or baked in the oven. These signs are in the shape of nails or wedges, hence the qualifier cuneiform given to this writing (from the Latin cuneus, which means wedge).

Ur, the city of Abraham
On the banks of the Euphrates develops during the next millennium, the city of Our. From this city would come Abraham, at the origin of the Hebrew people.
The necropolis of Our testifies to the greatness of the Sumerian civilization. With around 2,000 tombs, many of them richly furnished and decorated, it is contemporary with the pyramids of Egypt (2700 to 2500 BC).

We have preserved from the Sumerian period many cylinder seals, thousands of clay tablets covered with cuneiform characters and of course countless works of art: representations of gods and kings.

The standard of Our, known as the panel of peace (necropolis of Our, around 2500 BC)

They testify to the exceptional advances of this first civilization in intellectual and technological matters.

Thus textile production took off until it reached industrial dimensions. In agriculture, around 3000 BC. J.-C., the peasants invent the irrigation and also the plow with seeder. At the same time, the first wheels suitable for transport appeared (until then, the principle of the wheel was only applied to potter's wheels!).

Sumer's contributions extend to astronomy and calculation. Benefiting from a very pure sky, the inhabitants of the region took the time to observe the stars. They became very keen on astronomy and we owe them the sexagesimal division of time and the circle: 60 minutes in an hour, 24 hours in a day, 360 degrees in a circle. Thanks to the irrigation networks, the peasantry obtains significant surpluses which make it possible to feed many city dwellers. In this way, the largest of the Sumerian cities reached up to 40,000 inhabitants, at a time when the total population of the planet did not exceed a few tens of millions of men.

At the turn of the 3rd millennium to the 2nd millennium, after the year 2000 BC. J.-C., these cities will give way to a city of central Mesopotamia promised to the most glorious of destinies: Babylon and its fabulous hanging gardens.

The Greek and Roman cultures will then spread to Europe, then to the rest of the world from the Renaissance, forming the soil of the current "Western culture". Arab civilization is also an heir to this vast ensemble.

In ancient Greece, man, perhaps less worried about his survival, begins to step back and question his place in the universe. Nature is still venerated for its beauty and generosity, springs are honored and certain trees are celebrated, such as the olive tree of the Acropolis, but the gods lose their animal aspect and are relegated to Olympus. For philosophers, nature begins to be reduced to a unified whole, perfectly organized and subject to man: "If there are many marvels in this world. There is none greater than man" (Sophocles, Antigone).

So let's not be surprised that the Greeks showed brutality by remorselessly deforesting the Hellenic peninsula and the islands of the Aegean Sea, which Plato compared "to a body emaciated by disease" (Critias).

We can see in these late regrets the origin of the Latin locus amoenus ("pleasant place") to designate the original nature where the wise Lucretius would have liked to find beauty and rest (De natura rerum, 1st century BC).

This idealized nature is found in the myth of the Golden Age evoked by Ovid: "The earth, without being violated by the hoe, nor injured by the plow, gave all of itself" (Metamorphoses).

The Romans, in fact, never ceased to praise the life of the shepherds (Virgil, The Bucolics, 1st century BC), while celebrating their victory over savagery through the creation of towns and road networks.

Ode to nature
"Blessed old man, your fields will therefore remain to you! and they are large enough for you, although bare stone and muddy reed cover your pastures everywhere. Unknown grass will not harm your lambs, and the contagious disease of the neighboring flock infect yours. Fortunate old man! there, on the known banks of your rivers, near your sacred fountains, you will breathe the cool and the shade. Here the bee of Hybla, foraging on the flowering willows that surround your fields from their green enclosure, will often invite you, by its slight murmur, to taste sleep: and while from the top of the rock the pruner will push his song in the air, your dear pigeons will not stop cooing, the dove to moan, on the great abalones" (Virgil, The Bucolics, 1st century BC).

Disadvantages of a slave workforce
In the 1st millennium BC. J.-C., the rise in power of the Greek cities then of Rome does not lead to any progress in the life of the peasants. Greeks and Romans were satisfied with the servile labor provided by military campaigns. Later, the great naturalist Aristotle suspected that if the Greeks had to leave to conquer the riches of Persia, it was because they had eroded their hills by dint of agriculture.

In terms of agricultural progress, innovation comes from the north: the Celts, in other words "our ancestors the Gauls", designed the wooden barrel, more practical than terracotta amphoras, for storage and transport some wine. They also invented the ploughshare of the "Gallic plow" which made it possible to deepen the furrow and cultivate more difficult soils. In the 1st century AD, the vallus, a harvesting machine, even saw the light of day.

The Arab-Persian world
At the fall of the Western Roman Empire, Byzantium preserved the scientific heritage of Hellenistic Greece and transmitted it to the powers in the making, Islam and the Christian West.
In the lands conquered by the Muslim horsemen, including the Indian subcontinent, the peasants benefited from significant progress in the management of water as well as in the use of fertilizers and the diversification of species.

Having mastered new crops (pistachio in Syria, coffee in Yemen or orange in Andalusia...), the Arab-Persian world does not stop there and creates new varieties of flowers, such as the tulip. He is also interested in their classification to be able to better use their medicinal properties.

Cultural Revolution
Of the two millennia that elapse between 9,500 and 7,500 BC. J.-C., there remain to us remarkable vestiges on the site of Jericho, oldest of the current cities, like on that of Mureybet, at the edge of Euphrates (current Iraq).

These vestiges testify to a real cultural shock with the trivialization of agriculture, the appearance of livestock farming and the development of an urban civilization, with also a social hierarchy and segmentation by profession.

A new architecture emerges with houses with a rectangular plan. The round shape is therefore reserved for community houses or sanctuaries (like today the bedside of churches or the mirhab of mosques). The unburied rectangular houses and the first domesticated goats testify to the will of the men to be freed from the natural elements and to dominate them.

The Neolithic revolution spread fairly quickly from the Levant (the Jordan region) to Anatolia (present-day Turkey). Traces of it can be found in Cayönu and Nevali as well as in Catal Hüyük. The archaeological site of Catal Hüyük, near Lake Konya shows narrow houses, which are accessed by the roof (because of the cold climate of the region). This village would have been founded around 7,500 BC. Finally, between 7,500 and 6,200 BC. J.-C., it is the explosion, the "great exodus"! Migrants spread the urban and agro-pastoral economy of the Neolithic beyond the Middle East, towards Europe as well as towards the Zagros Mountains (Iran).

From Paradise to Purgatory
Medieval culture revives nostalgia for the earthly Paradise where Man lived in peace. Unfortunately, the best things have an end and here are the men condemned to subsist in a hostile nature from which they must tear off their subsistence day after day.

Following the collapse of Roman institutions, major invasions and depopulation, the forest took its revenge everywhere. Consumption of unleavened bread in Codex Vindobonensis, 14th century, Vienna, ÖsterreichischenNationalbibliothekAfter the year 1000, agricultural reconquest was favored by global warming and population growth.

Sedentarization and agriculture everywhere have incalculable consequences on social organization. Everyone must protect themselves against the risk of being stripped of their crops and provisions. Thus are born the property and the right which is attached to it.
But one can never be too careful: from the 4th millennium BC, one begins to add palisades and ditches which transform the villages into fortified camps. Communities, more and more numerous, indeed begin to compete with each other and observe each other with a bad eye.

In the Celtic or Gallic world, this evolution gave rise to the 1st century BC. AD to the oppida (plural of oppidum), strongholds located high up, surrounded by cyclopean walls and perfectly organized with craftsmen near the main gate, then the residences of the nobles, finally, in the center, the sanctuary .

In the Carolingian era, from the 8th century, they gathered spontaneously around chapels and cemeteries, in search of comfort and solidarity. The first village communities were formed around these parish enclosures, which are the sign of the Christianization of the countryside. Later, with the rise of insecurity, the peasants also found protection in the shade of the first fortified castles, rustic wooden constructions which served as a refuge for a lord and his men (...).

It is no longer quite a village but rather a city, with its diverse social functions. The surrounding countryside is dotted with isolated farmhouses and family cabins.

The clearings and the extension of plowing cause the forest and the moor to retreat everywhere, to the point of worrying the lords, great hunters before the Eternal. In 1346, by the ordinance of Brunoy, the king of France Philippe VI severely limits the rights of use in the forests of the royal domain "so that they can perpetually be removed in good condition". It is undoubtedly the oldest ecological law in the world! Our countryside takes on its current aspect with the meshing of the territory by villages and monasteries, very active in the management of the natural heritage. Paths, canals and ponds, hedgerows and groves reshape the landscapes and humanize them while enriching their biodiversity.

The peasantry, over the generations, has selected animal and plant varieties adapted to their land. Here, where insects are rife, we have, from one year to the next, gradually eliminated cereals with smooth ears to retain only those with hairy ears, which do not allow insects to bite the seeds; there, where caterpillars are most prevalent, we have preserved plants with smooth leaves, on which butterflies cannot lay their eggs... Thus the traditional peasantry has increased biodiversity! In fact, when a peasant grew cereals and at the same time raised animals, the excreta of these were spread in his fields and allowed a short cycle of nutrients in nitrogen, phosphorus and carbon. The peasantry has been able to develop know-how that respects the environment and the future.

The Olmec and Caral civilizations
In Mexico, the Olmec civilization will lead to the rise of all the civilizations of Mesoamerica, of which the Mayas and the Aztecs are the best known. In Peru, many civilizations will succeed that of Caral, on the Pacific coast as on the Andes plateaus: the latest arrivals, the Incas, are also the best known.

The same applies to the Mayan civilization (9th-11th centuries), in Central America, whose collapse was caused by intensive slash-and-burn agriculture leading to deforestation and wear and tear on the soil and gigantic floods due to torrential rains caused by the El Nina - El Nino cycle.

The shock of the Great Discoveries
The day in 1492 when Christopher Columbus set foot on the American continent, the history of the relationship between man and nature took off. We know the human consequences of the Great Discoveries: the reduction of 90% of the Amerindian population in

150 years mainly due to the involuntary introduction of the small-pox virus, against which the Amerindians, unlike the Europeans, were in no way immune. Conversely, Europeans leave with syphilis. To this "microbial shock" are added the Indian wars and the massive introduction of African slaves. (...)

Each civilization has seen its development based on the intensive cultivation of particular plants. However, these plants are more particularly adapted to the climate where they were domesticated: this climate constraint is therefore found in the area of distribution of the first civilizations.

Chinese and Indian civilizations
China exported its culture as far east as Korea and Japan, and as far south as Vietnam. As for Indian civilization, it radiated as far as Indochina and Indonesia, as their names indicate.

In the Far East, in Song China (10th-12th centuries), the domestication of nature, rivers and mountains was pursued with the same assiduity with dykes and terraces. The Chinese Orient is not outdone in agricultural matters with the invention at the beginning of the Christian era of the indispensable wheelbarrow then, in the 6th century, of the moldboard plow with a metal share which allows draft animals to less fatigue (...).

As in the West, peasants are developing an agriculture that saves natural resources and are learning to manage shortages. Chinese cuisine preserves the memory of this shortage through the art of accommodating leftovers.

Cities are exploding thanks, among other things, to the development of trade along waterways, some of which are artificial, such as the Grand Canal, which links Beijing to Hangzhou over 1,700 km.

Further south, the Khmers brought tropical nature into line around Angkor, where they undertook gigantic hydraulic works to establish their religious metropolis (9th-14th century). But the excess of their company will lead them to their loss...

Hong Liangji, Qing dynasty. This Chinese official Hong Liangji (1746-1809) has already analyzed the possible consequences of overpopulation in a finite world, in a book entitled Government and Welfare of the Empire (1793).

Both a drunkard and an outstanding engineer, Hong Liangji is an inspector in the miserable province of Guizhou, in southwestern China. He realizes that the population of his province has been multiplied by five in three decades, under the effect of internal migrations in China and the milder climate. He assesses the growth of a typical family, calculates the possible progress in terms of crop intensification and extension of agricultural land, and concludes that the state is headed for disaster.

In a century, he says, the population will increase ten or twenty times, while agricultural production will at best quadruple and more likely double. Living frugally will not be enough to stem the catastrophe. In his book, Hong poses a question, "Does the cosmos have an answer to such a situation?" And he answers, "Yes. Floods, droughts, and epidemics are the instruments of the cosmos to make necessary adjustments."

Hong Liangji well anticipated what was going to happen in China in the 19th century. He just forgot to mention the war (opium war, Taiping revolt etc.), which will combine its effects with those of floods, droughts and epidemics. In 1799, the Chinese government took notice of the publication of his book and censored it, making Hong understand that he must be silent... or disappear. He opts for discretion.

The demographic limits
From modern times, in China as in the West, these pre-ecological concepts sometimes take on accents that we consider prophetic.

Thus, in Europe, the Reverend Malthus published anonymously in 1798 his Essay on the Principle of Population. The work is the argument of a pessimist. It aims to nail the beak of the author's father, the archetype of the optimist. The progenitor of Malthus, like a majority of his compatriots, is convinced that humanity can by its industry transform the Earth into paradise, because such is the will of God.

Malthus defends that there are limits: according to him, the human population has a capacity for growth exceeding the capacity for agricultural production. Whenever food is plentiful, it feeds a population growth which creates new mouths and quickly reduces this gain to nothing, creating the conditions for a famine which in turn decimates the population.

The author, acclaimed, republishes his work, this time assuming his signature and recommends not to help the poor - they would take advantage of it to multiply, according to him.

In describing this "trap" or "Malthusian ratchet", linking population growth to the availability of resources, Malthus is both right and wrong, which is why his work (like contemporary ecological alerts) has generated the most extremes.

He is right because his rule has been effective throughout human history. He is wrong because the British society in which he lives is just beginning to emerge from the trap he has just described, with the Industrial Revolution, the ability to drain resources from around the world through colonization and then international trade, and the use of fossil fuels.

At the end of the 18th century, in the Europe of the Enlightenment, the dominant consensus was that land clearing and agriculture softened the climate and created weather conditions conducive to the flourishing of civilization. Therein lies the explanation that Europe is civilized and the Americas not yet.

In 1780, Buffon, in Les Époques de la nature, explained that "the face of the Earth today bears the imprint of the power of man". He goes so far as to speculate that humanity will one day be able to "modify the influences of the climate it inhabits and fix its temperature, so to speak, at the point that suits it".

Agriculture and types of climate

Let's review the different types of climate involved.

* Wheat was grown in a Mediterranean climate: the associated civilizations, such as Egypt and Mesopotamia, therefore occupied hot and dry regions.
* The development of Chinese civilization was based on the cultivation of millet, domesticated in a cold and dry climate. It was only later that China appropriated the cultivation of rice during its progress towards the south.
* Indian civilization is based on the cultivation of rice, characteristic of a hot and humid climate. It was the same with China from the time of the Empire.
* The civilizations of Mesoamerica were based on the cultivation of maize, adapted to a rather hot and humid climate.
* The Andean civilizations based their development on potato cultivation, limited to the cold and dry altitude climate.

A first conclusion can be drawn from these observations: the diversity of climates that allowed the emergence of the first civilizations is surprising given their importance for the agricultural sector. These occupied almost all environmental niches, from cold and dry regions to hot and humid regions.

Conversely, two regions with an apparently similar climate could have led to radically different evolutions: thus the lower Mississippi valley and that of the Rio de la Plata in America did not experience the rise of the Ganges plain in India. , despite climatic analogies (hot and humid subtropical climate). Similarly, the banks of the Orange River in South Africa, and those of the Murray River in

Australia, have not experienced the same development as the Nile, the Tigris, the Euphrates and the Indus, although they also irrigate desert regions. As for the plain of the Danube, climatically comparable to that of the Yellow River (cradle of China), it did not allow the rise of any ancient civilization. Thus, in this first superficial vision of things, the role of the climate in the rise of the first civilizations seems to be almost nil...

Climatic stress, creator of civilizations.

The climatic diversity observed between civilizations masks a very real common denominator: climatic stress. To detect this, we will put forward a hypothesis: a company is not motivated to demonstrate innovation if the environment does not offer it a spur. In particular, it is the specter of famines which invites us to domesticate nature in order to increase the abundance of food.

When the frost becomes the accomplice of the barbarians

They also sometimes have unexpected geopolitical consequences. Thus on December 31, 406, the Vandals, accompanied by the Alans and Sueves, passed into Gaul by crossing the Rhine which had exceptionally frozen that year. For several years, these Germanic peoples, pushed by the advance of the Huns in the east of Europe, tried to penetrate into the Roman Empire. Until then, they had been repulsed, in particular by the Franks allied to Rome, who had caused them heavy losses near the Danube. We find them at the end of December 406 much further north since they cross the Rhine opposite Mainz, which they then loot.

The imperial troops, monopolized by the internal struggles and the threats of other peoples, in the forefront of which the Goths, show themselves unable, and even unwilling, to react. In the months and years that followed, they left the attackers to attack the cities of the region (Reims, Trier), then spread throughout Gaul, before crossing into Spain in 409.

High Middle Ages: beyond the imaginable

The chronicles provide us at the beginning of the Middle Ages with a list of particularly cold and harsh winters, such as 763-764, 859-860, 1076-1077... Let us remember in passing that the extreme cold is not the only cause of famine: Intense rainy episodes during the summer can also have dramatic consequences by causing the wheat to rot. The monk Raoul Glaber thus recounts a famine in the 1030s in Burgundy: "Continuous rains had soaked the whole earth to the point that for three years we could not dig furrows capable of receiving the seed. At harvest time, the bad grasses and sad weeds had covered the whole surface of the fields".

When the cold sets in, the horrors go beyond the imaginable: "Alas! something rarely heard over the ages, a rabid hunger drove men to devour human flesh. Travelers were carried off by those stronger than themselves , their limbs cut off, cooked in the fire and devoured. who had welcomed them. Many, by showing a fruit or an egg to children, lured them into remote places, slaughtered them and devoured them. The bodies of the dead were in many places torn from the ground and also served to appease the hunger...".

The "Little Ice Age"

After three centuries of relative mildness, during which harvests became more abundant and the European population tripled in number, winters returned in force in the 15th century and more especially from the 1550s until around 1860, during what we called the "Little Ice Age", with an average temperature drop of just under a degree Celsius.

The winter of 1407-1408 was particularly cold and long, marked by two long periods of frost, from mid-November to the end of January, then from mid-February to the beginning of April. The rivers are frozen or carry ice cubes. The supply by river, essential in the Middle Ages, becomes problematic and the mills can no longer function, yet they represent an essential source of energy for many activities. Both wine and ink freeze in their containers and firewood is scarce.

Geopolitics of Heat: Greenland, History and Climate

The Middle Ages experienced a modest thaw, the consequences of which were nevertheless significant, as evidenced by the chronicles on Greenland.

It was in 982 that the Viking Eric the Red discovered a large ice-laden island with a few meager meadows on the coast. He baptized it Greenland, a name which means "green land", just to attract settlers there!

Eric the Red was able to access Greenland thanks to global warming that lasted from the time of Charlemagne (8th century) to that of Saint Louis (13th century). This "medieval optimum" freed Greenland from its barrier of floating ice, at least in summer, and facilitated the development of coastal meadows. The small Viking settlement disappeared at the end of the Middle Ages with the return to colder temperatures.

"The medieval optimum resulted in a temperature rise of a few tenths of a degree", specifies Hervé Le Treut, director of the dynamic meteorology laboratory (Pierre and Marie Curie University, Paris). "It therefore has nothing to compare with the current global warming which will result in a rise in temperature of 2 to 6°C by 2100".

Nevertheless, this slight softening of the climate facilitated major clearing on the European continent and contributed to the increase in population... The climate historian Emmanuel Le Roy Ladurie wrote in 1967: "Without doubt, the climate of these four centuries, from the Carolingians to the great clearings, seems to have been quite mild, as mild as in the 20th century, or perhaps even a little more; and it is not unreasonable to think that the Vikings took advantage of this (unknowingly) to colonize the northernmost and harshest margins of their expansion: Iceland and Greenland.
But it is hardly possible to go beyond these cautious assumptions. (...) A simple example, among ten other possible ones: the hazel tree did not reconquer in the 11th century its "optimal" positions towards the north of Scandinavia..." (History of the climate since the year one thousand, Flammarion , 1967).

Deadly heat waves
Appearing at the end of the 15th century, the word "heat wave" comes from the Latin canicula which means "little female dog". It was under this name that Sirius, the main star of the constellation Canis Major, and the brightest star in the sky after the Sun, had been baptized. Sirius rises and sets at the same time as the Sun from July 22 to August 23. As it is during this period that high temperatures are most frequent, the expression "days of heat wave" which originally referred to the period of the year when the star was visible, gradually ended up designating the extremely hot days.

In our temperate latitudes, mortality is usually higher in winter than in other seasons, the elderly or sick people having difficulty supporting the drop in temperature and the shortening of the days. For this reason, we are more frightened by harsh winters than by scorching summers. However, the chronicles show that heat peaks, with drought, epidemics and the fires that accompany them, have always caused more damage and victims than extreme cold.

If the scorching summers have been the cause of recurrent health disasters, it is primarily due to water shortages, with the level of groundwater tables dropping drastically during periods of drought. Less abundant, the water becomes more muddy and its consumption generates bacterial infections, such as dysentery, an intestinal disease that was a real scourge. In the Middle Ages, dysentery thus took away many sovereigns: Louis VI the Fat, Louis VIII, Saint Louis, Philippe V, Jean sans Terre or even Edward I and Henry V of England. Over the following centuries, it claimed the lives of the conquistador Hernan Cortès, the writer Étienne de la Boétie, the corsair Francis Drake and the explorer David Livingstone.
Climate stressors

India is a good example of a region with a very marked alternation of dry and wet seasons (monsoon Asia). It has to deal with frequent climatic stress. India is a good example of a region with a very marked alternation of dry and wet seasons (monsoon Asia). It has to deal with frequent climatic stress.

We can identify at least two climatic factors influencing this "environmental stress".
Regions with high variability in annual precipitation experience very high water stress: a delay or advance in the rainy season can have catastrophic consequences. This climatic feature could be a powerful driver for innovations. Hot and humid regions tend to promote the spread of diseases, especially through mosquitoes (this is still one of the major causes of death in the world today). If it is diseases that drive demography instead of famines, the notion of environmental stress pushing innovation disappears.

Climatic factors of the creations of civilizations.
Based on these reflections, the study conducted in Civilizations put to the test of climate isolates three climatic factors whose joint presence could constitute a major driving force in the transition to history:
* a sufficient annual amount of precipitation (> 500 mm);
* fairly low winter temperatures (< 13°C);
a sufficient rainfall ratio between the wet season and the dry season (> 12).

This leads to the climate map below, superimposed on the map of the first centers of civilization.

The analogy is almost perfect: no autonomous civilization has ever emerged away from one of the climatic centers put forward. And conversely, all climatic outbreaks have indeed led to the emergence of a civilization. There is only one exception, located around the Sino-Burmese border: it is the only zone which does not adjoin either a plain or a plateau. This undoubtedly prevented the geographical unity essential to the rise of a civilization: in fact, everywhere else in the world, civilizations developed in the flat zones bordering the climatic hearths.

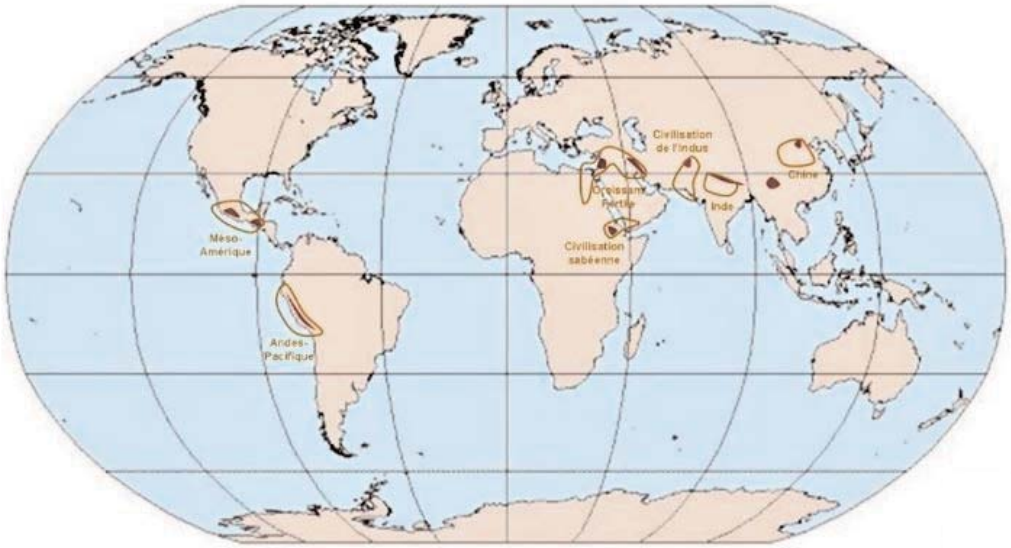
These observations tend to confirm that the birth of History responded to a strong climatic determinism: the diversity encountered in the development of the different regions of the world does not in any way appear random.

The role of climate, crucial in the transition from prehistory to history, persisted throughout antiquity. Thus, one can note that the diffusion of civilizations step by step was facilitated by the existence of a common climate. The ten richest major countries on the planet occupy latitudes greater than 30°: a coincidence?

Civilizations remain in their original climate type
For example, the "wheat civilizations" from the Fertile Crescent continued their diffusion in all regions with a Mediterranean or dry subtropical climate: to the east on the Iranian plateau (Persia), to the west on the shores of the Mediterranean (Greece, Carthage, Rome...). Conversely, these civilizations initially abandoned the regions further north (Central Asia) and south (Sub-Saharan Africa), with distinct climates. It was only later that they progressed in Europe, first favoring its western part with the mild winters of the time of the Roman Empire, then gradually spreading towards its eastern part, colder, during the Middle Ages.

Everywhere else in the world, civilizations have remained within their original climatic domain. This trend is easy to understand since the economy of civilizations has remained dominated for a long time by the agricultural sector, which is highly dependent on the climate; however each cereal is more adapted to the climate where it was domesticated.

Does latitude determine the wealth of a country?



Each climatic focus gave rise to the birth of civilizations

On the other hand, one might think that the role of the climate has weakened since the industrial revolution, that is to say during the last two centuries. But the current distribution of wealth in the world tends to indicate that this is not the case. Below are the economic capitals of the ten richest countries with more than 10 million inhabitants on the planet, and the ten poorest.

It can be seen that the 30° latitude appears as a natural limit, with the rich countries beyond and the poor countries below. The only exception is Afghanistan, a poor country located at more than 30° latitude: this is easily explained by the quasi-permanent wars that have taken place in recent decades.

Thus, Man has certainly succeeded in freeing himself from the constraints of his environment by various means (air conditioning of offices, heating of houses, manufacture of vaccines and medicines, spreading of agricultural fertilizers, etc.); but this has a cost, and the most favorable regions today would be those where this cost is lowest, namely the temperate regions.

The Poisons of Humanity

Human activities have always affected the environment and health, but the phenomenon amplified with the industrial revolution two and a half centuries ago, until it got carried away today.

Water and air pollution, disfigurement of cities, occupational diseases, climate change... These evils are not inevitable if we are to believe the researchers François Jarrige and Thomas Le Roux, authors of a remarkable sum, The Contamination of the World, a history of pollution in the industrial age
Very early on, in the Middle Ages, public opinion was concerned about the nuisances associated with industry. The word pollution itself, which originally designated defilement, was used for the first time in 1804 in the sense that we know of it. It is by Scottish judges who sentence tanners for pollution of the stream.

The first legislative measure relating to industrial pollution is a decree of the government of Napoleon I "relating to Manufactures and Workshops which spread an odor or inconvenient" dated October 15, 1810. It divides these establishments into three classes, the most inconvenient (3rd class) that must be kept away from dwellings. The administration, and no longer the judiciary, is now empowered to examine complaints from residents.

At first glance, we can see a saving awareness of the risks and disadvantages generated by the emerging industry. In fact, according to François Jarrige and Thomas Le Roux, it is rather a clever sleight of hand. Disputes relating to industrial pollution are no longer arbitrated by the local courts and police, as in the past, but entrusted to the administration, which can call on "experts" to clarify its decisions. And guess who these experts are related to? Not to citizens who contest progress in the name of futile neighborhood and health inconveniences, but to industrial and scientific circles. The best example of these "experts" at the service of science and industry is the chemist and industrialist Jean-Antoine Chaptal...

Economic capitals of the 10 richest countries and the 10 poorest countries with 10 million and more citizens

In the Middle Ages, pollution under control
Without going back to the men of Lascaux who could suffer from smoke fumes in caves and rock shelters, we know that industrial pollution already existed in Roman times from the traces of lead from this period found in the ice of the arctic. However, it was in the Middle Ages, after the year 1000, that it began to pose a problem, due to the economic take-off of the West, with the emergence of fairs, towns and crafts.

This era is the blessed reign of renewable energies: wood and charcoal, water and wind. Historian Jean Gimpel estimates at around 1000 Megawatts, or the power of a nuclear reactor, the power provided by the 500,000 windmills and watermills that meshed Europe at the end of the Middle Ages. This is not nothing for a population smaller than that of present-day France!

The construction of cathedrals is the source of serious environmental disturbances. It is thus estimated that the construction sites of the Paris Basin led to the excavation of a volume of limestone greater than all the stones extracted to build the pyramids of Egypt. They also consumed a lot of metals: iron but also lead for stained glass and pipes. It is part of this lead that went up in smoke in the terrible fire of Notre-Dame de Paris, April 15, 2019.

Forests are shrinking like never before. They are eroded by the cutting of timber and firewood and by the production of charcoal. It is to the point that on May 29, 1346, by the ordinance of Brunoy, the king of France Philippe VI of Valois decides not to grant any more rights of use in the forests of the royal domain. It prescribes that "water and forest agents be required from time to time to visit all wooded areas, to investigate and have them exploited, so that they can be permanently removed in good condition". We can see in this text the first environmental protection law!

Charcoals and mills are used by millers but also textile and leather craftsmen. These booming activities were the source of the main industrial pollution in the Middle Ages.

The rivers are thus polluted because of the textile industry, first of all the "retting" of hemp and flax, a maceration which aims to separate the fibers from the stem. The same consequences with the maceration of old rags in the drums of paper manufacturers. The dyeing of fabrics also pollutes water and generates olfactory nuisances. But it gets worse with the use of alum, a highly prized aluminum sulphate for fixing colours. Mainly extracted from the Tolfa mine, in the Papal States, it is refined in various places at the cost of highly polluting operations (cadmium fumes, sulphates, etc.).

Also installed on the banks of the river, the tanneries process the skins in water tanks where substances such as "tan", a boiled bark of wood, are diluted. These processes generate appalling odors and pollute the water to the point of making it toxic. For this reason, tan-

neries are set up in rural areas or downstream from towns. There will be more than 5,000 in France alone at the end of the 18th century. The tanners' district of Marrakech still offers a watered-down vision of these medieval processes.

Traditional law, built on custom (common law in England) is very picky when it comes to trust. Artisans have the obligation to work in full view of the public and their customers. Those who commit nuisances can be sentenced to fines, establishment closures, monetary compensation, or even imprisonment, as François Jarrige and Thomas Le Roux point out. "In London, someone who, by wanting to make oil of vitriol or etching [sulphuric acid and nitric acid], would come to corrupt the air and affect the health of his neighbors, puts himself in the event of being brought to justice and suffering a sentence proportionate to the damage he has done", writes a jurist of yesteryear.

These provisions will last until the eve of the French Revolution, including in the English colonies in America where English law applies: permission from the local police is required to install a potter's or baker's stove or an activity polluting.

In Paris and in the major French cities, the police also ensure that activities deemed inconvenient are expelled outside the walls. This philosophy is summed up superbly by a certain Antoine-François Prost de Royer, former lieutenant general of police in Lyon, quoted by François Jarrige and Thomas Le Roux: air can be vitiated, so as to alter health, the magistrate must proscribe or expel....

Convenience, private profit are nothing: what is everything, and what must regulate justice, it is the healthiness of the air; it is public health. Salus populi, suprema lex esto".

These words measure the shift that will take place at the start of the industrial revolution, at the end of the 18th century, when it comes to freeing companies from all constraints...

The scientific revolution at the end of the 19th century initiated a reversal of the trend. The laboratories launched research on high-yielding plants, and as it would have been too costly to develop varieties adapted to each terroir, they developed varieties for universal application and corrected their weaknesses by resorting to increasingly massive to phytosanitary products or chemical amendments (fertilizers). From now on, we can thus find the same varieties of wheat, corn or rice in all the cereal plains of the world.

The development of the nitrogen fertilizer industry follows the Great War. During this, nitrate was produced en masse for the manufacture of explosives. When peace came, the factories were converted to the production of nitrogen fertilizers. The use of nitrogen fertilizers has also been favored by the end of polyculture and the specialization of agricultural production. Today, for lack of manure at their disposal, cereal growers have to resort to chemical fertilizers, while breeders have to treat slurry without profit for anyone... and with what is more damaging changes in the fauna and flora of the river and coastal waters.

It follows that some large intensive farms can turn out to be destructive of capital. They are in their own way as predatory as the first farmers who burned the virgin forest and degraded the soil for a few meager harvests. These farms may, on closer examination, prove to be less efficient than traditional or "organic" family farms which use very few chemicals, large machinery and hydrocarbons, although with a gross yield per hectare of two or three times lower.

Meeting the Challenges of the Industrial Age

If we wanted to return to a rational approach to the peasant economy, we would have to measure the value added per unit produced by subtracting from its market value all the costs: seeds but also "inputs" (nitrogen fertilizers, machinery, pesticides) and imported animal feed (transgenic soybean meal). It goes without saying that

agro-industry would turn out to be much less profitable under these conditions than we think! Namely that small farms are more productive than large ones.

The science of the house: This is the meaning of the term ecology, constructed from the Greek oikos, house, and logos, science. The term appeared in 1866, from the pen of the German biologist Ernst Haeckel (1834-1919). It qualifies a science, which aims to study the interactions between living beings and environments.

In the 1960s, experts and activists became aware that living environments (ecosystems) were degraded by our activities. They warn about the disappearance of animal or plant species, deforestation, pollution… The movements resulting from this awareness, by getting involved in the political field, form a political ecology. This is to be distinguished from scientific ecology.

To better distinguish between political ecology and scientific ecology, we can say that an ecologist is an activist, while an ecologist is a scientist in biodiversity and ecosystems. The two may occasionally come together.

First struggles against pesticides
One of the most symbolic stages of ecological awareness was the publication, in 1962, of the book Silent Spring by the biologist Rachel Carson (1907-1964).

To combat an invasion of fire ants, the Department of Agriculture has planes spray DDT and other toxins over huge areas Rachel Carson finds that these products concentrate on the ground, in water, poison the birds. In particular, they would weaken the shells of their eggs, could cause their extinction, extinguish their songs forever. It suggests that biocides could constitute a health threat to human beings, and proposes their limitation to the strict minimum possible.

The book is a success. The clumsy reaction of the industrial lobbies, who try to make Rachel Carson pass for an enlightened while she is well known to the general public for her previous works on the ocean, discredits them. Mobilization of public opinion led to the banning of DDT in the United States in 1972.

DDT has since been classified as a probable carcinogen and reprotoxic. It was responsible for a decline in bird populations in North America, probably linked to its excessive efficiency: by decimating insects, it starved the birds.

However, the use by agriculture of similar products, organochlorines, has exploded since the publication of Silent Spring. And their toxicity has increased sharply, the insects being subjected to a selection favoring the genes allowing them to resist these poisons.

This first mobilization of the environmental movement was perhaps a Pyrrhic victory. By banning a product effective in the fight against insects, he pushed for it to be replaced by more toxic ones.

The problem was rather a question of scale, which Rachel Carson had anticipated. The effectiveness of these substances was such that no politician or industrialist could then consider doing without them. It would have been necessary to impose practices limiting their spreading to what is strictly necessary, which has not been done.

The risks of progress
Industrial disasters

The risks associated with the urban establishment of industries appeared with the gunpowder factories. After the explosions that occurred on the site of the Arsenal, to the east of Paris, in 1538 and 1563, these installations were moved away from the cities (that of Paris was transferred to Essonnes and will explode several times during the 18th century). century), but in 1794, in the context of the levy en masse, the Committee of Public Safety decided to concentrate the manufacture of arms in Paris.

A gunpowder factory was installed at the Château de Grenelle, near the Champ de Mars, inside the wall of the Farmers General. Hastily installed under the direction of Chaptal, it brought together more than 1,000 workers. On the morning of August 31, 1794, a gigantic explosion devastated it and killed around 600 people. Windows were shattered in almost all of Paris... Several other blowing snows exploded in the months that followed. During another politico-military crisis, on May 17, 1871, a cartridge factory exploded on Avenue Rapp, west of Paris, killing several dozen workers. Other explosions still took place in powder mines in the 20th century.

However, until the 1970s, industrial disasters were less urban than mining. The Courrières firedamp explosion of March 10, 1906 left a deep mark on working-class memory (more than a thousand victims).

A special case is that of the Ocean Liberty. This Norwegian ship, which was transporting ammonium nitrate, caught fire and exploded in the port of Brest on July 28, 1947. The whole city, which had already been razed during the war and was still made up of barracks, was hit by debris , and fires.

The fear of chemistry wakes up with the drama of Seveso. This town in the industrial zone of Milan was affected on July 10, 1976 by a major leak of toxic fumes in a factory of the Swiss pharmaceutical group Hoffmann-Laroche. The group hides this toxicity from the authorities for several days and in doing so exposes the inhabitants of the surrounding area to serious risks, even if no direct death will be deplored. Following this alert, the European Commission adopted a first directive in 1982, called "Seveso I" (two have since followed). It imposes preventive measures on companies according to the risks incurred. However, the limits of these injunctions appeared on September 21, 2001 when a tank of ammonium nitrate stored in the AZF factory in Toulouse exploded, killing 31 people and injuring 2,500, as well as considerable material damage. The factory was subsequently razed to make way for a cancer research laboratory, with all the symbolism associated with the installation of medical equipment on the site of such an accident.

At the start of the 21st century, despite everything, Europe can be pleased that industrial disasters are becoming relatively exceptional on its soil. This is mainly due to the fact that dangerous and dirty activities have been relocated to emerging countries in Asia.

A first glimpse of this phenomenon was given to us by the Union Carbide disaster in Bhopal, India, on December 2, 1984 (3,800 dead and several hundred thousand people affected). Several countries in South Asia today receive toxic industrial waste from the West, while China, which has become the "workshop of the world", inherits the problems that were those of Europe at the end of the 19th century, air pollution, chemical pollution, mining and industrial disasters.

These are recurring. If the dangerousness of Chinese coal mines is slowly reduced due to the modernization of facilities, the same is not true of chemical complexes which, initially built away from urban areas, are gradually overtaken by them. , which makes the accidents in these factories all the more dramatic. The recurring tragedies in the chemical sector, which accounts for 14% of China's Gross Domestic Product (GDP), signify the failure of the regulatory measures taken after the tragedy in Tianjin, which, on August 12, 2015, caused 173 deaths and nearly 800 injured. The explosion had been described by some as "Chinese Seveso" (Le Monde diplomatique, February 2020).

Demographic concerns

In 1968, the spouses Paul and Anne Ehrlich published La Bombe P, P for Population, in which they considered that there was not enough agricultural land to feed humanity. They predict that a massive famine will decimate the Earth in the 1970s and 1980s, and recommend that States take strong and immediate measures to limit population growth.

In fact, if the demographic progression of the human species is phenomenal (1 billion around 1807, 2 billion in 1925, 3 billion in 1960, 4 billion in 1975, 5 billion in 1987, 6 billion in 1999, and 7.7 in 2020…), the environmental footprint of humanity is a function of its way of life as much as its number.

Esther Duflo and Abhijit V. Banerjee recall, in their latest book (note), that "10% of the world's population (the biggest polluters) contribute about half of global CO2 emissions, and the 50% who pollute the least only contribute a little more than 10%". Similar reports hold more or less for all environmentally damaging practices.

The simple fact of living in a rich country like France makes its inhabitants, even if they only benefit from minimal income or social assistance, people using many more resources than if they lived in Mali. If only because the State and companies create and maintain urban infrastructure, transport, communication...

Ultimately, technologies will never succeed in completely cutting it off from the very substrate on which they are built: that of planet Earth...

When the earth turns into a desert: how to save the last soils?
Qualified as the "greatest environmental challenge of our time", desertification already affects 500 million people in 168 countries and a third of the planet's surfaces. A phenomenon that is accelerating, especially with global warming. Or when the ground crumbles from under humanity's feet…Why the ground matters. The soil, the living epidermis of the planet, provides 99% of the food on which humanity depends. Overexploited by human activities, it is eroding, drying up and becoming exhausted: according to the United Nations, 40% of the world's land is already degraded, affecting half of the world's population. Intensive agriculture, responsible for 90% of global deforestation, is singled out. Faced with this global deterioration of soils, arid zones - which encompass nearly half of the world's land surface - are particularly vulnerable. Coupled with global warming, the phenomenon is intensifying and accelerating - land degradation occurring at a rate 30 to 35 times faster today than historically. Continuing this momentum, an additional area equivalent to South America could be degraded by 2050.

The time of mobilizations
April 22, 1970 is celebrated in the United States as the first Earth Day. The event is promoted by Wisconsin Senator Gaylord Nelson. He encourages students to mobilize to force the government to pass environmental protection laws.
Enlargement shows the poster used for Earth Day April 22, 1970 features the Pogo cartoon character, created by Walt Kelly. It reads "we have met the enemy, and it is us", Houston Chronicle.

The audience brought together by Rachel Carson and the Ehrlich spouses fuels the success of this mobilization, against a backdrop of apocalyptic predictions combining famines, shortages and pollution. 22 million people demonstrate in the United States, which pushes the government of Richard Nixon to create the Federal Agency for the Protection of the Environment.

In 1990, Earth Day became global.

A media debate in the 1970s opposed Paul Ehrlich to the liberal economist Julian Simon. The latter is convinced that the free market will solve all the problems. The exchanges are so polarized that they paralyze any judgment. The apocalypse predicted for the 2000s will not take place, nor will the paradise of prosperity announced by J. Simon. The Green Revolution, which allows several poor countries to produce more agricultural resources by intensifying pollution, may have helped to avoid famines while the population was growing strongly in Asia. In Africa, subsistence agriculture has progressed sufficiently to support strong population growth, without a sharp increase in chemical inputs, but by conquest of agricultural areas to the detriment of wild environments. The extension of free

trade has boosted trade, and enriched a middle class that has become global. Economic growth has slowed sharply.

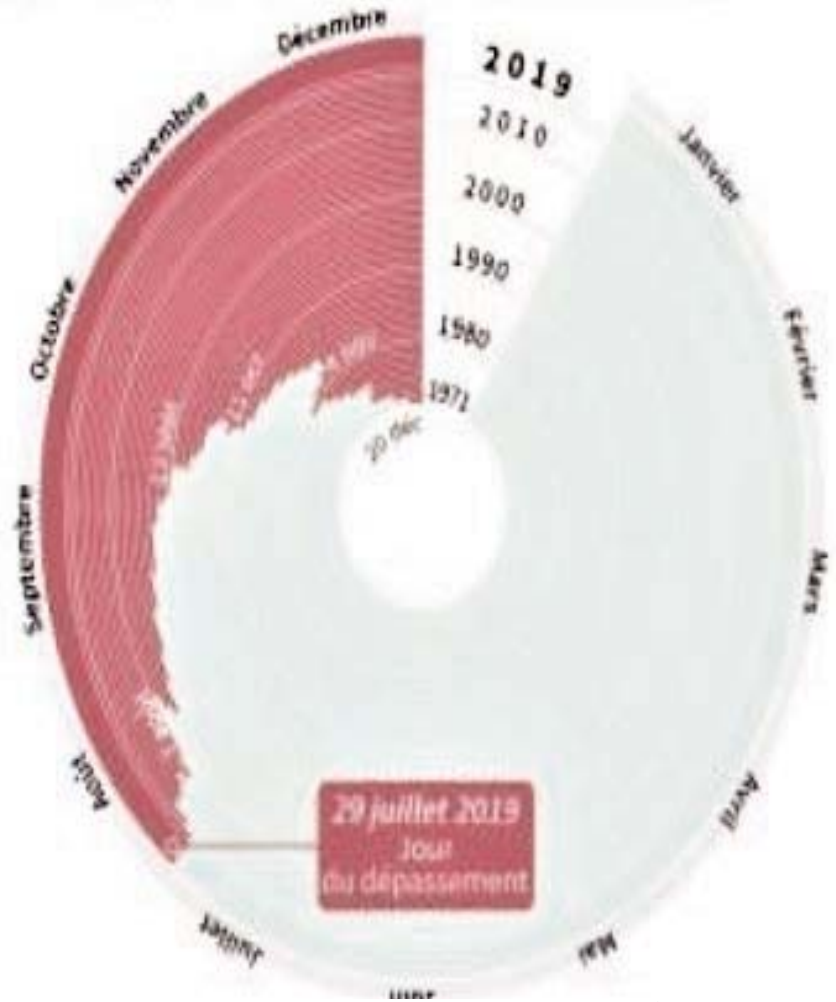
Scientific announcements

In 1972, a team of scientists from MIT published a report at the request of the Club of Rome, an association of international decision-makers concerned with the question of planetary boundaries. The synthesis, known as the Meadows report (from the name of its editor, Dennis Meadows), is very innovative in forward-looking terms. It is based on a mathematical model processing a large number of parameters by computer (a first for the time). Contrary to what is often said, the document does not pose any dated prediction. Its general conclusion simply implies that the economic and demographic growth of humanity will lead sooner or later, in any case before the 2100s, to a dislocation of the planetary parameters underlying our living conditions.

Several scenarios are developed. They cause fundamental parameters to vary and interact, such as our ability to recycle mineral resources, to control pollution, to find new sources of energy... Eventually, the experts diagnose, humanity will experience a demographic recession caused by a deterioration of his living conditions.

Humanity has been living on credit since July 29.

Overshoot Day symbolizes the time of year when the resources that the Earth can renew in a year have been consumed

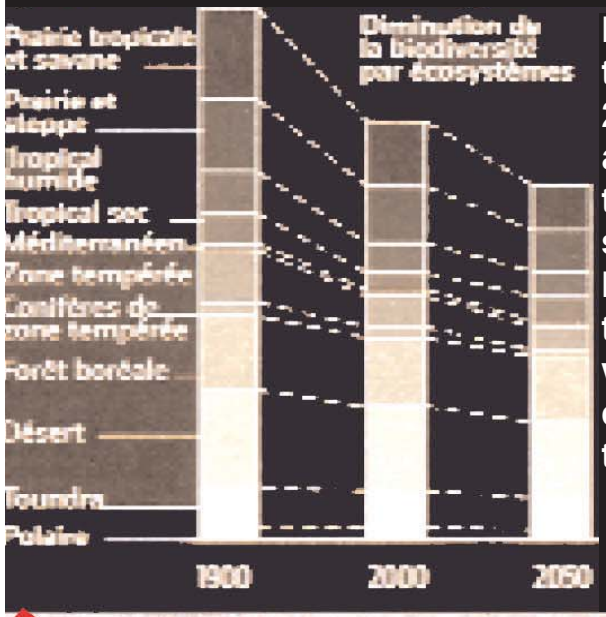


Duration and carbon consumption of humanity

Absorbable and regenerated by the Earth
What the Earth can no longer regenerate

Ecosystem

Tropical and temperate zones will be particularly weakened

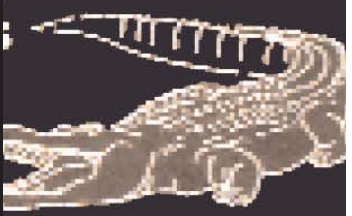


In a century, ecosystems have lost nearly 20% of their wealth and the trend will continue. Savannah, steppe, tropical and boreal forest will be the most affected while desert and polar ecosystems will be threatened

Adaptation

Some organisms will shrink… For 1% increase in temperature, fish and salamanders will be among those that shrink the most.

And others will see their energy needs increase
For fish, insects and reptiles, a 1% rise in global temperature will speed up their metabolism by at least 10%. This will increase their food needs.



6,1

It is in kilometers per decades, the rate of movement of fauna and flora in the face of global warming

5

It is per decade, the number of additional days of growth caused by global warming in animal and plant species. They will warm up sooner and go dormant later.

What concepts does biodiversity cover?

The term "biodiversity" refers to the diversity of species on the surface of the globe. If the notion of diversity of species within ecosystems dates back to the 1940s, the diversity of living things is now understood in a more complex way: we distinguish ecological diversity which corresponds to the different environments in a landscape, the diversity in species of an ecosystem and finally the genetic diversity within a species, distributed among different individuals. These three levels of diversity are all to be taken into consideration, because they are interdependent.

A debate developed in the 1960s: did the diversity of species in a community guarantee its stability? The controversies continued until the end of the 1970s. In fact, from an evolutionary perspective, the important thing is to note that the current biodiversity is inherited from history and constitutes the only potential for evolution for the future. .

Hence the concern caused by the disappearance of species, which took on a new dimension in the 1980s, with the extent of the losses linked in particular to the intense deforestation of tropical forests: we then began to speak of a "crisis of biodiversity. This awareness led to the signing, at the Earth Summit, of the international convention on biological diversity. This remarkable event in the history of humanity has not closed a complex debate, where the points of view on the importance of biodiversity, on its possible uses, on its appropriation...Through the world, according to the cultural, social and economic situations, the points of view are diverse, even divergent. The "Northern" countries, while they legitimately claim a pioneering role in nature conservation, cannot conceal their responsibilities in the biodiversity crisis, including in the "Southern" countries. These, for their part, raise the question of who owns the wealth, actual or potential, represented by the biodiversity carried by their territories. How do scientists fit into the debate?

Schematically, two currents emerge. For many scientists, including systematists, biogeographers, inventory specialists, it is biodiversity in its totality that counts, each species being important. For others, mainly ecologists, the central question is that of the functions of biodiversity, which leads to the question whether all species are essential. This question opens the door to the idea that species could be useless, and would therefore not deserve to be kept. We are thus in the presence of two cultures, even of two ideologies. Asked to help public decision-making, scientists can therefore provide different, sometimes contradictory, insights.

How to approach biodiversity between scientific knowledge and social project?

Since Linnaeus' founding work (1758), only one million five hundred thousand species have been identified and named. But there would be 10 million, or even many more! Many people think that at the current rate of destruction many species will disappear before scientists have been able to inventory them.

The question which therefore arises for humans is: "knowing that biodiversity is decreasing, what do we want to do with it?" and the debate opposes the proponents of "every living being has a value in itself and deserves respect" and those of " a living being only interests us if it renders services to humans". The appearance of this very anthropocentric notion of "service provided" by biodiversity is quite recent. Who then decides on the usefulness or uselessness of such a gene, such a species, such an ecosystem? Inevitably, biodiversity raises philosophical and ethical questions, interfering with the spiritual and religious fields.

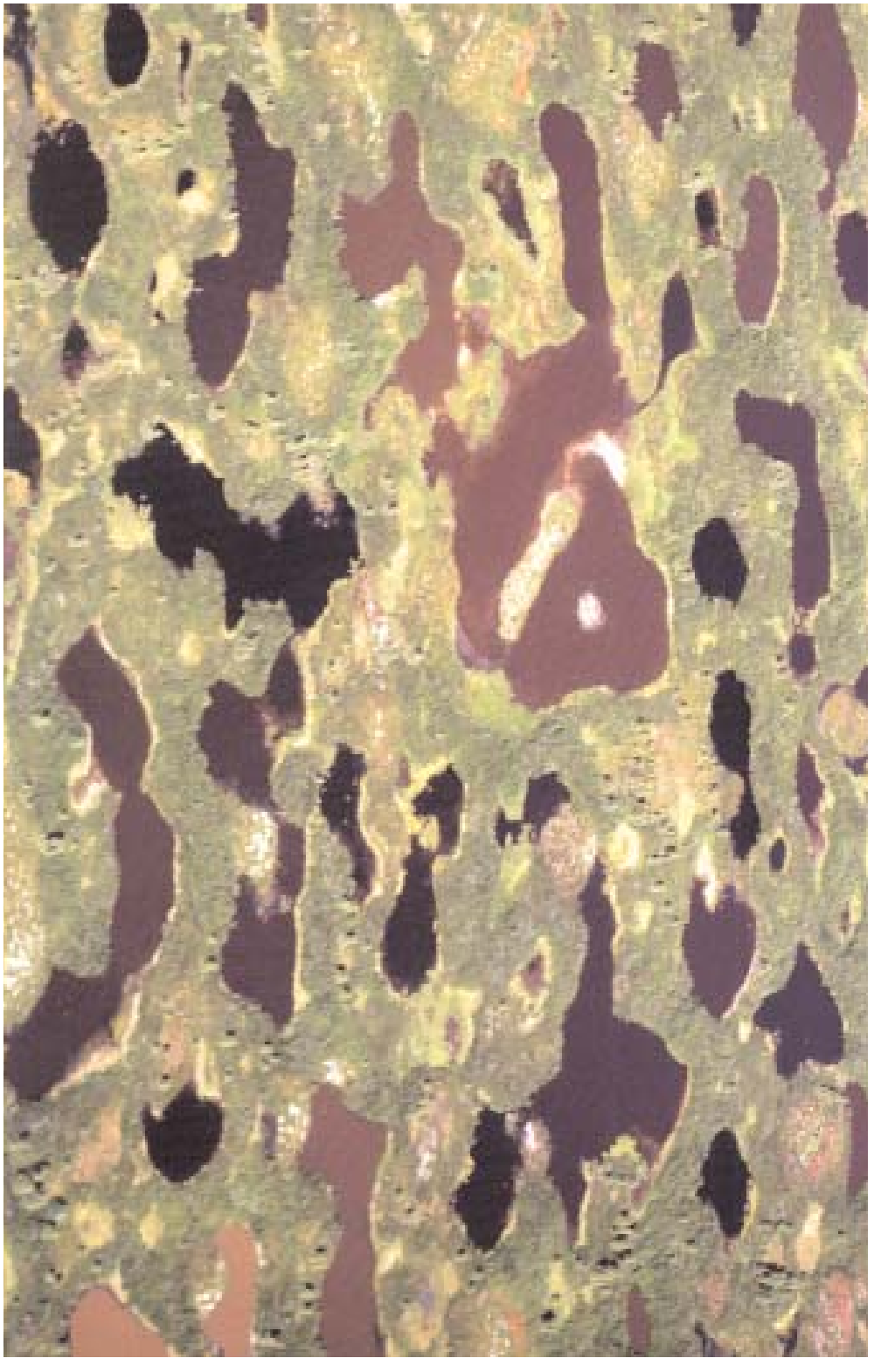
Faced with this, is it not the responsibility of scientists to explain in what and how biodiversity can be a potential for evolution, at the different levels of organization at which it is apprehended?

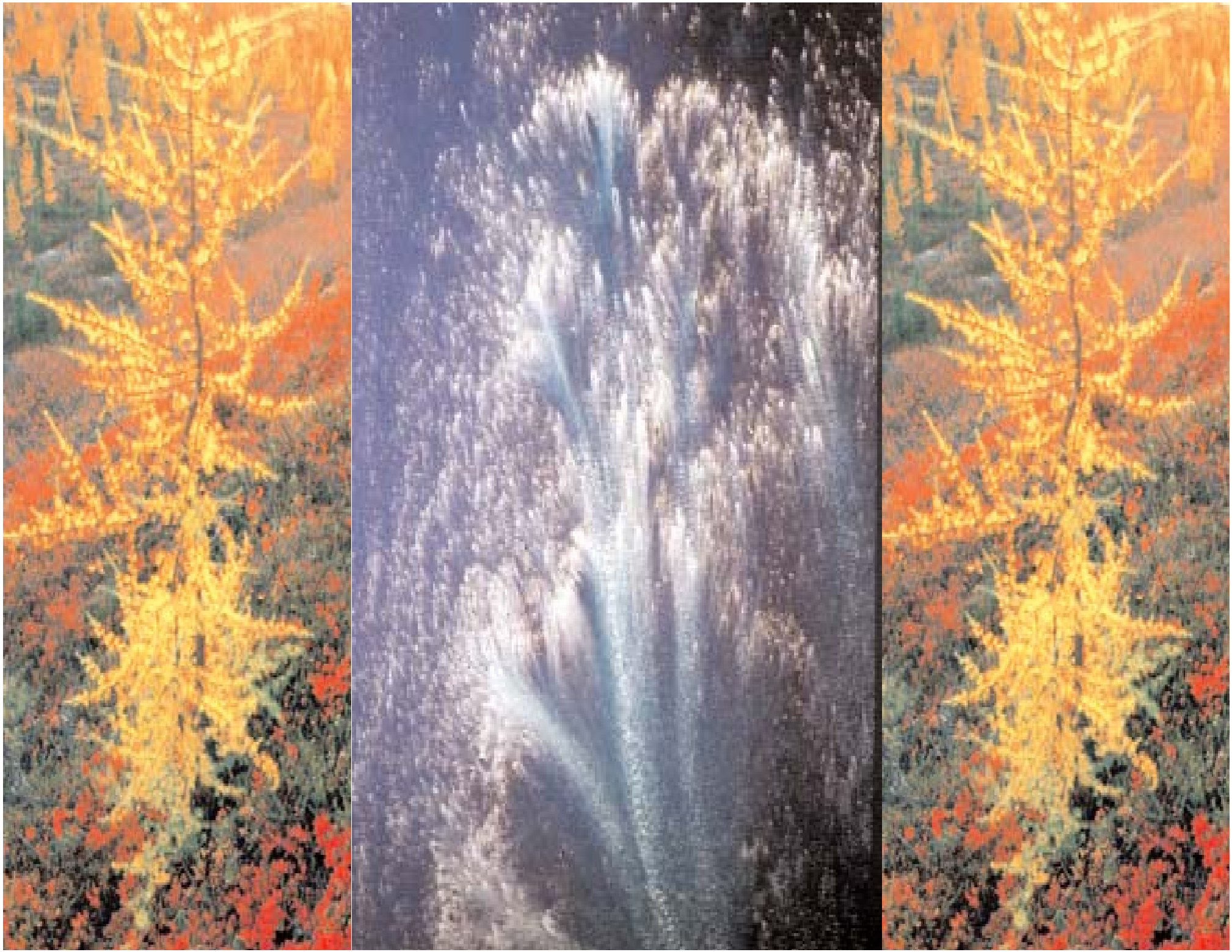
Nature is constantly changing. The living adapts and thanks to that

survives, and this because it is diverse. If we reduce biodiversity, aren't we reducing the potential for adaptation and therefore for evolution? But, taken to the extreme, wouldn't a "conservationist" vision be contradictory, because fixist? Do we have references in the past to define for eternity what would be, in a territory, the "good" biodiversity? How to pass judgment on the arrival, spontaneous or provoked, of new species in a region? This is why some plead in favor of an "evolutionary ethics" which would have to be invented, of a philosophical approach which would make it possible to give an ethical value to change or to evolution.

"With what biodiversity do we want to live tomorrow" would then be the real question.

The future of biodiversity thus appears as an essential element of any societal project, a project built through debates ensuring the confrontation of ideas, including those that scientists must contribute, thanks to a growing - but never complete - knowledge of biodiversity. .



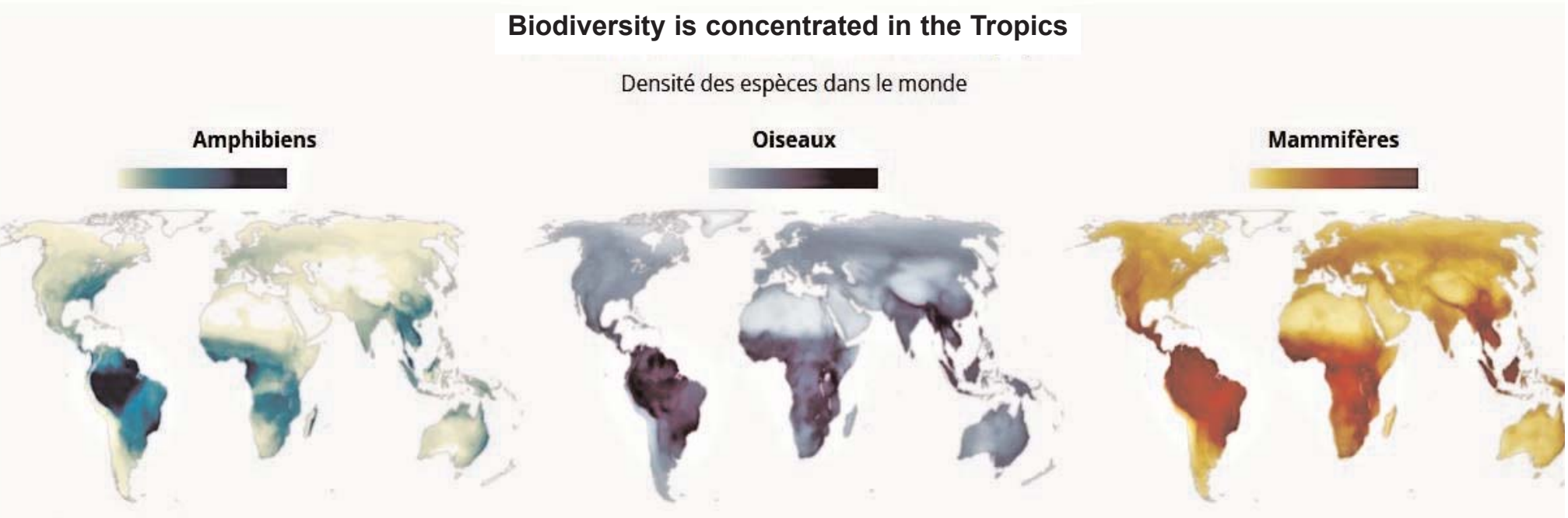


Biodiversity at risk

All over the world, wild species are threatened with extinction. Each extinction results in a loss of biodiversity, that is, the irreversible loss of a unique species and a decrease in the overall variety of life on the planet. Biodiversity loss often follows habitat destruction, due to deforestation or desertification for example. Deforestation is a particularly serious threat to wildlife, as forests are a major source of biodiversity on earth.

stable climates over millions of years have enhanced plant productivity and created rich sets of food chains. Over time, natural selection processes - prey-predator systems for example - have allowed species to adapt and diversify repeatedly. These conditions are not easily replicable outside of centuries-old tropical ecosystems.

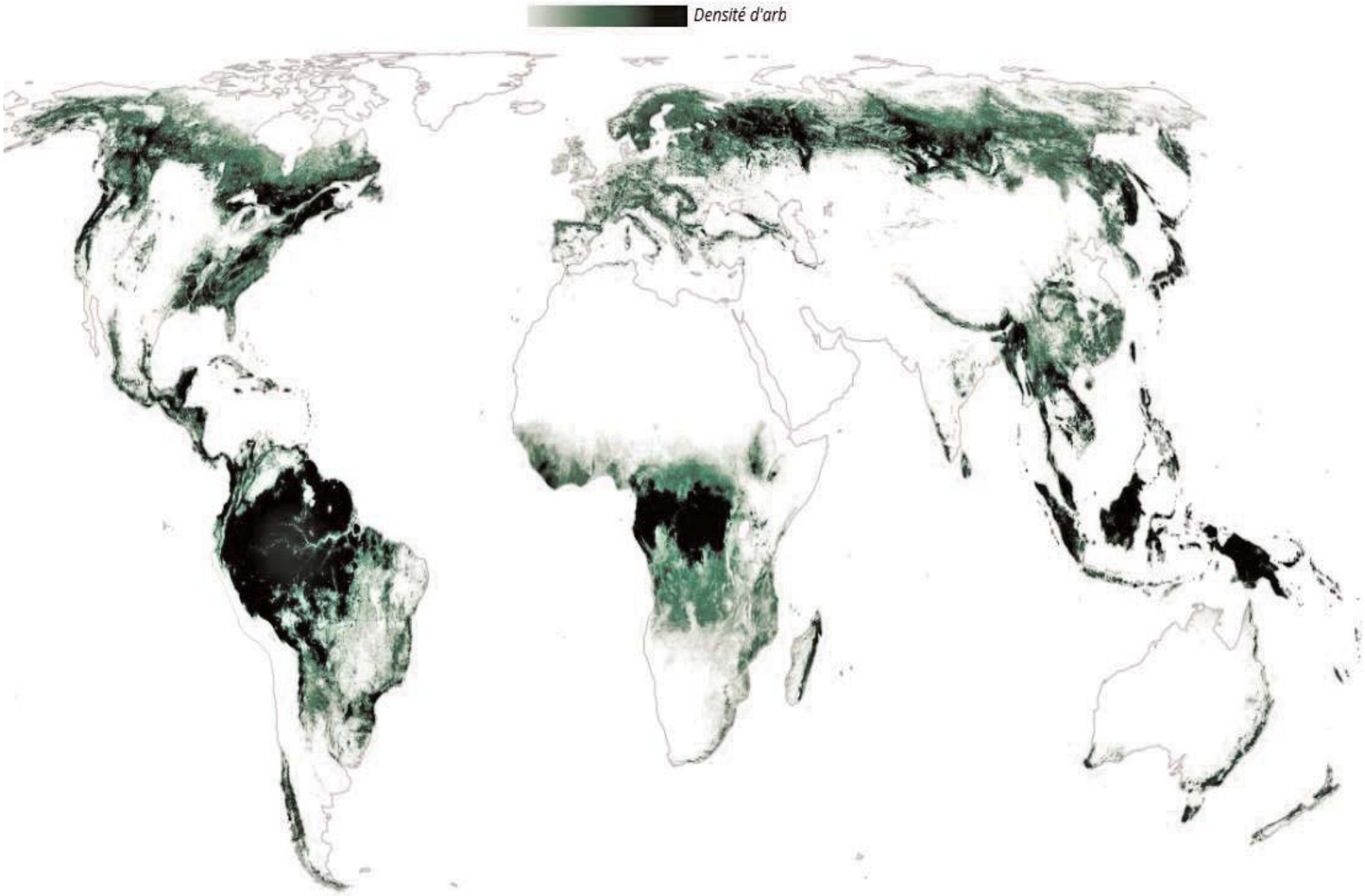
Forests, and in particular tropical forests, are essential to global biodiversity. Yet between 2010 and 2015, the planet suffered a net loss of 16.5 million hectares of forest, an area equivalent to that of



The global risk of extinction has increased in most countries since the 1990s. A small number of countries are home to most of the world's biodiversity. Species density is particularly high in and around the tropics. It is home to about 90% of land bird species and more than 75% of amphibians, land mammals, freshwater fish, ants, flowering plants and marine fish. Most of these species are only found in intact or old-growth rainforests, environments typical of tropical regions.
In tropical regions, abundant rainfall and sunshine combined with

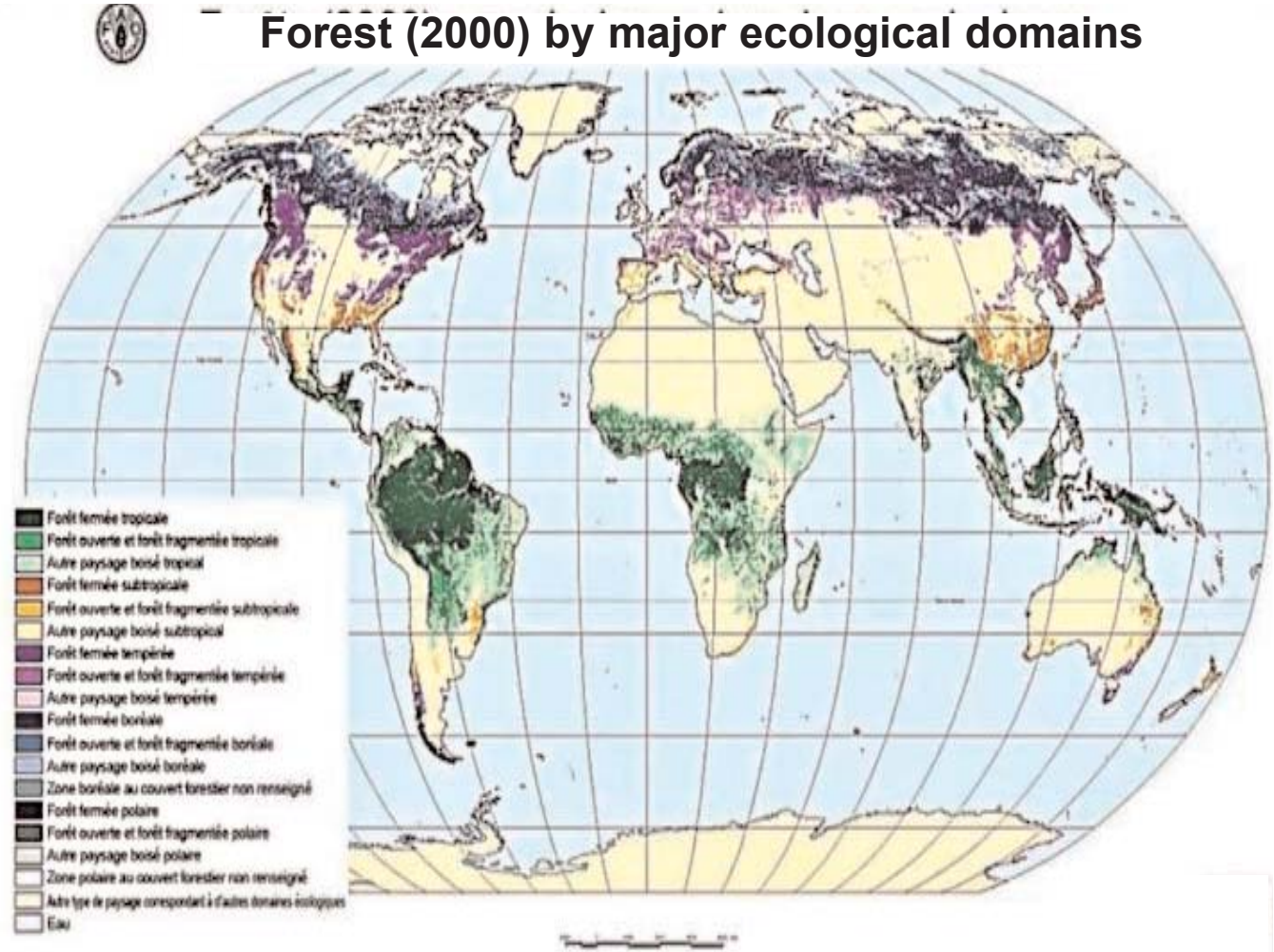
Tunisia or the US state of Georgia. Losses have been most severe in dense, intact and biodiverse forests in tropical countries. Gains have occurred mainly in areas of secondary and sparse reforestation in temperate regions, which contribute less to global biodiversity.

Global forest cover in 2010



e : M.C. Hansen et al, 2013, « High-Resolution Global Maps of 21st-Century Forest Cover Change ». *Science*, v. 342, n° 6160, pp. 850-853 [article, données]

Biodiversity at risk


Forest (2000) by major ecological domains
Forêt fermée tropicale
Forêt ouverte et forêt fragmentée tropicale
Autre paysage boisé tropical
Forêt fermée subtropicale
Forêt ouverte et forêt fragmentée subtropicale
Autre paysage boisé subtropical
Forêt fermée tempérée
Forêt ouverte et forêt fragmentée tempérée
Autre paysage boisé tempérée
Forêt fermée boréale
Forêt ouverte et forêt fragmentée boréale
Autre paysage boisé boréale
Zone boréale au couvert forestier non renseigné
Forêt fermée polaire
Forêt ouverte et forêt fragmentée polaire
Autre paysage boisé polaire
Zone polaire au couvert forestier non renseigné
Autre type de paysage correspondant à d'autres domaines écologiques
Eau

DISTRIBUTION OF FOREST TYPES BY ECOLOGICAL DOMAINS

All over the world, wild species are threatened with extinction. Each extinction results in a loss of biodiversity, that is, the irreversible loss of a unique species and a decrease in the overall variety of life on the planet. Biodiversity loss often follows habitat destruction, due to deforestation or desertification for example. Deforestation is a particularly serious threat to wildlife, as forests are a major source of biodiversity on earth.

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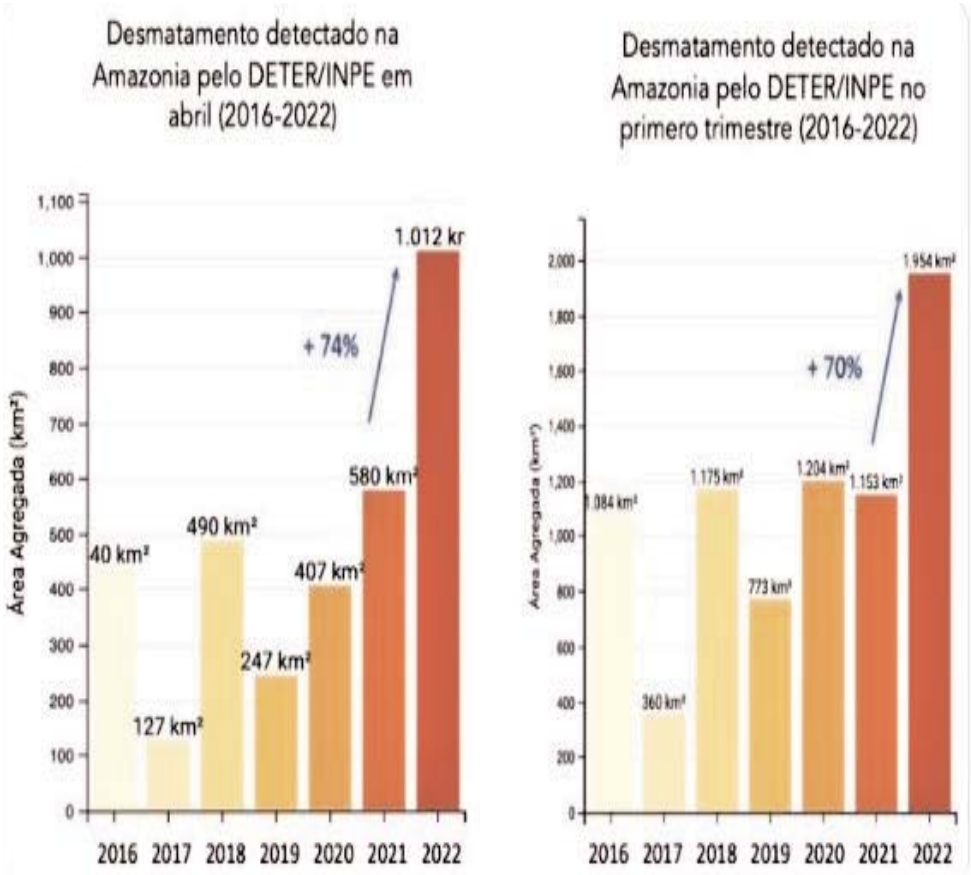
In tropical regions, abundant rainfall and sunshine combined with stable climates over millions of years have enhanced plant productivity and created rich sets of food chains. Over time, natural selection processes - prey-predator systems for example - have allowed species to adapt and diversify repeatedly. These conditions are not easily replicable outside of centuries-old tropical ecosystems.

Forests, and in particular tropical forests, are essential to global biodiversity. Yet between 2010 and 2015, the planet suffered a net loss of 16.5 million hectares of forest, an area equivalent to that of Tunisia or the US state of Georgia. Losses have been most severe in dense, intact and biodiverse forests in tropical countries. Gains have occurred mainly in areas of secondary and sparse reforestation in temperate regions, which contribute less to global biodiversity.

Since climate models show that warming will dry out the region, there is also an urgent need to limit our greenhouse gas emissions on this front in order to contain this climate change. And since our footprint hurts the Amazonian forest, it seems just as essential to drastically reduce logging in the region.

Once a point of no return is reached, large ecosystems will disappear at an unexpected speed. For example, it would not take more than 50 years for the Amazon rainforest to transform into a savannah-type ecosystem if 35% of its surface were "cleaned".



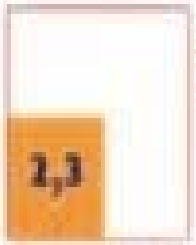
The harvest rate in 2022 is nearly 70% higher than in 2021, a record year since the start of the series in 2016.

En millions de km²		
En 1990	**Toutes**	***Lowland rainforests***
Afrique	5,3	0,9
Asie continentale	1,4	0,3
Asie insulaire	1,7	1,4
Amérique Centrale	1,2	0,5
Amérique du Sud	8,0	4,1
TOTAL	17,6	7,2

Années	**1500**	**1990**
Afrique	1,5	0,9
Asie	2,5	1,7
Amériques	5,0	4,6

Forêts tropicales humides de plaine (millions de km²)

L'Amazonie



8,4 millions de km²

Territoires indigènes

15%
de la biodiversité terrestre mondiale

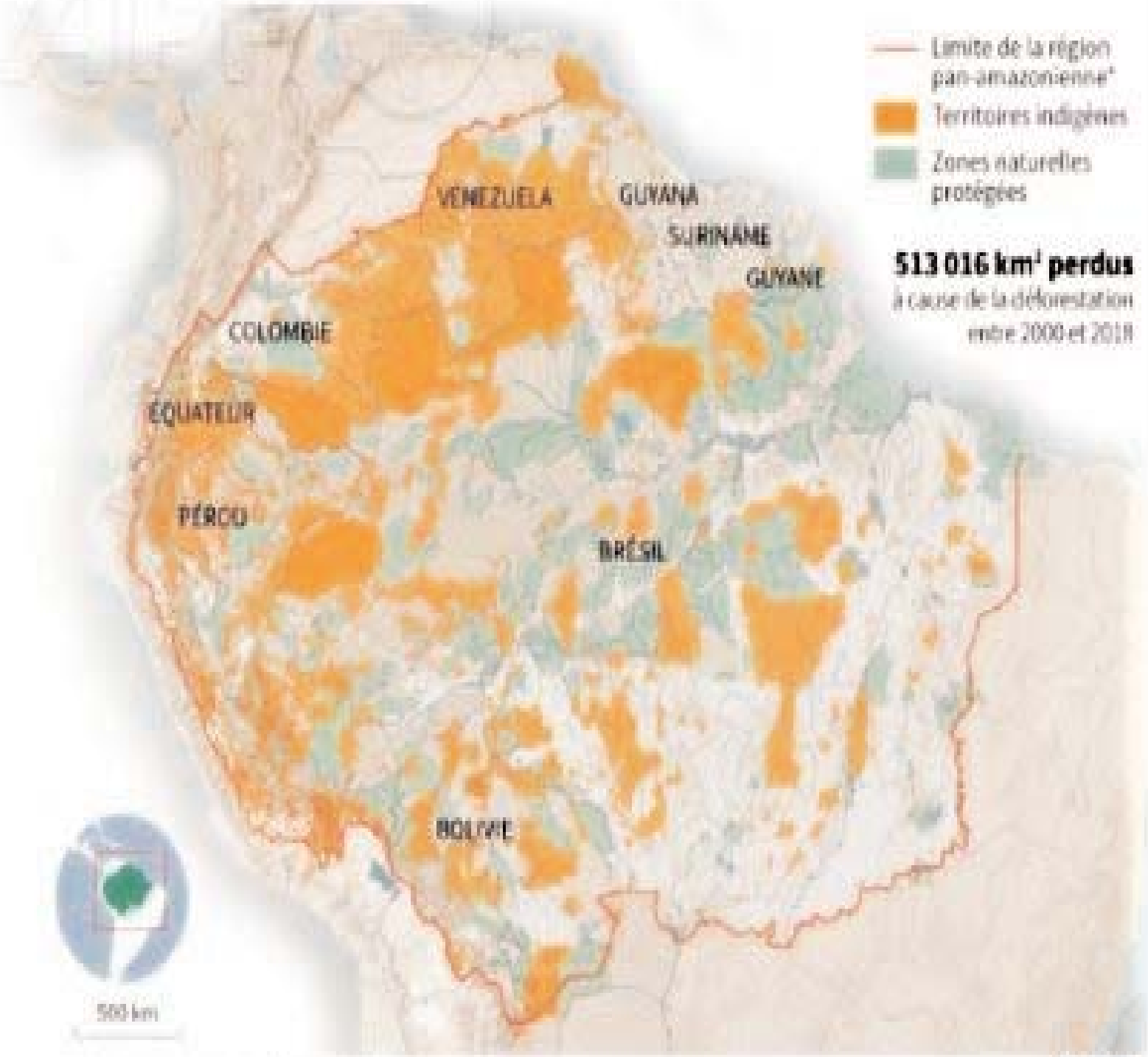
15 à 20%
de l'eau douce

47,4 millions
d'habitants

- Région peuplée de paysans
- Plus de **250** dialectes parlés

Plus de 500 groupes ethniques

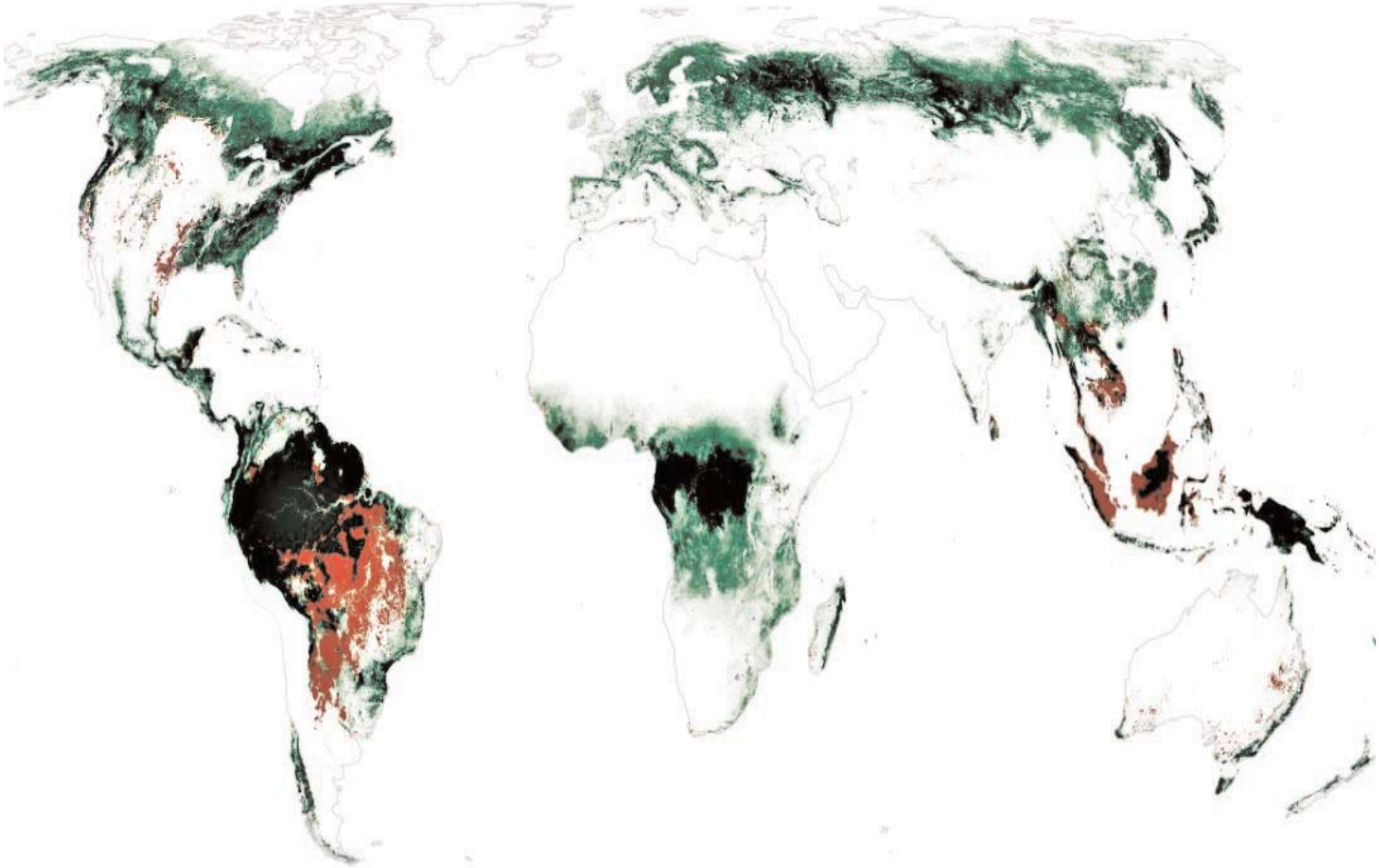
- **90** vivent isolés du monde extérieur



513 016 km² perdus
à cause de la déforestation entre 2000 et 2018

Areas affected by forest loss 2001 - 2015

Large Scale Deforestation Urbanization



es : P.G. Curtis, C.M. Slay, N.L. Harris, A. Tyukavina et M.C. Hansen (2018). « Classifying drivers of global forest loss ». *Science*, 361(6407), 1108-1111 ; Global Forest Watch.

	Nombre d'arbres	Nombre d'espèces
Barro Colorado (Panama)	235 317	305
Mudumalai (Inde)	17 432	68
Pasoh (Malaysie)	320 903	817
Lambir (Malaysie)	339 266	1171
HKK (Thailand)	96 072	251

Of the approximately 250,000 species of flowering plants, approx. 170,000 (2/3) live in the tropics, including around 85,000 in Central & South America.

At a given tropical forest site, say 1 hectare, tree species richness ranges from 23 (Nigeria) to 300 (Amazonia). By comparison, there are only 50 tree species in the whole of Europe. Or, a maximum of 30 tree species per hectare in the richest forests of North America (southeast of the Appalachians).

In the richest Amazonian lowland forests, on one hectare, ¾ of some 300 tree species are represented by only 1 or 2 individuals. In other words, at the km2 scale, the majority of tropical tree species are rare. The European concept of identifying a forest type by its dominant species does not apply in the Amazon.

What we commonly call "Reptiles" (snakes, crocodiles, turtles) has 5500 species worldwide; 1200 species in South America, including 550 in neotropical forests, including 270 in the lowland Amazon basin; including 159 in Guyana.

And on the side of "frogs" (Amphibian anurans): about 4500 living species are known today, including 1600 in neotropical regions. In Guyana alone, 103 species are listed, while only 33 are known in mainland France.

At the scale of the locality (= within a radius of 3 km), there are 2 to 4 times more higher vertebrates (Mammals, Birds, Amphibians, Reptiles) and 3 to 10 times more Arthropods in tropical regions than in temperate regions.

In Amazonia, the richest sites are upstream of the tributaries of the Amazon, at the foot of the Andes: 550 birds and 140 mammals within a radius of 3 km in Cosha Cashu, Peru, compared with 180 birds (apart from non-breeding migrants) and 66 mammals for all of mainland France.

The plant complexity of the tropical forest is perpetually maintained by falling trees, which create windthrow or "forest canopy gap" at the rate of 1% of the surface per year. An old falling tree drags between 3 and 10 other trees in its fall, and this opening in the canopy brings abundant light to the ground, and the rapid regrowth of pioneer species.

In fact, the dynamism of the forest brings about a patchwork of stand ages, with all the intermediate stages between the young secondary recruit and the mature primary forest.

It is this "multiplication of available niches" that leads in places to an animal biodiversity that is spectacular. Three examples:
1) in an Amazonian site in Ecuador, 81 species of Amphibians, that is as many as for all the United States;

2) on a tree in the Peruvian Amazon, ED Wilson collected 43 species of ants, as many as the biodiversity of all of Great Britain;

3) over 200 m of a small stream (2 m wide), a tributary of the Mana River in French Guiana, more than 70 species of fish have been counted, i.e. the equivalent of all the fish fauna (81 species) in mainland France French.
Tropical forests provide an ecosystem whose three dimensions are enormous, with a rich diversity of plants, and a multiplicity of different food resources (but not necessarily abundant all the time!).

Studying small arboreal mammals requires access to the canopy to take samples, observations, ... One of the least expensive techniques is that of climbing to the top of the trees, after passing a cord then a rope by a main branch from the top of the targeted tree.
There are all kinds of specializations:

1 - specialization over time: diurnal & nocturnal species
- among the 86 non-flying mammals of Guyana, 21 species are diurnal, 52 are nocturnal, and 13 are both diurnal and nocturnal. To which are added the 100 nocturnal species of bats.

Nombres approximatifs d'espèces

	Mondial	Amérique du Sud	**Amazonie**	**France**	**Guyane**
Plantes vasculaires	250000				5300
Reptiles	**5500**	1200	**270**	**41**	**159**
Amphibiens	**4500**		**320**	**33**	**103**
Poissons	**20500**		**3000**	**81**	**480**
Oiseaux	9700	3000		545	740
Mammifères	4800	1150		139	186

2 - Specialization in space
It is necessary to go beyond the simplistic terrestrial/arboreal dichotomy, to recognize different strata offering different niches. In Gabon, the different species of squirrels of similar size preferentially exploit different layers of vegetation, while species of very different sizes share the same level of vegetation.

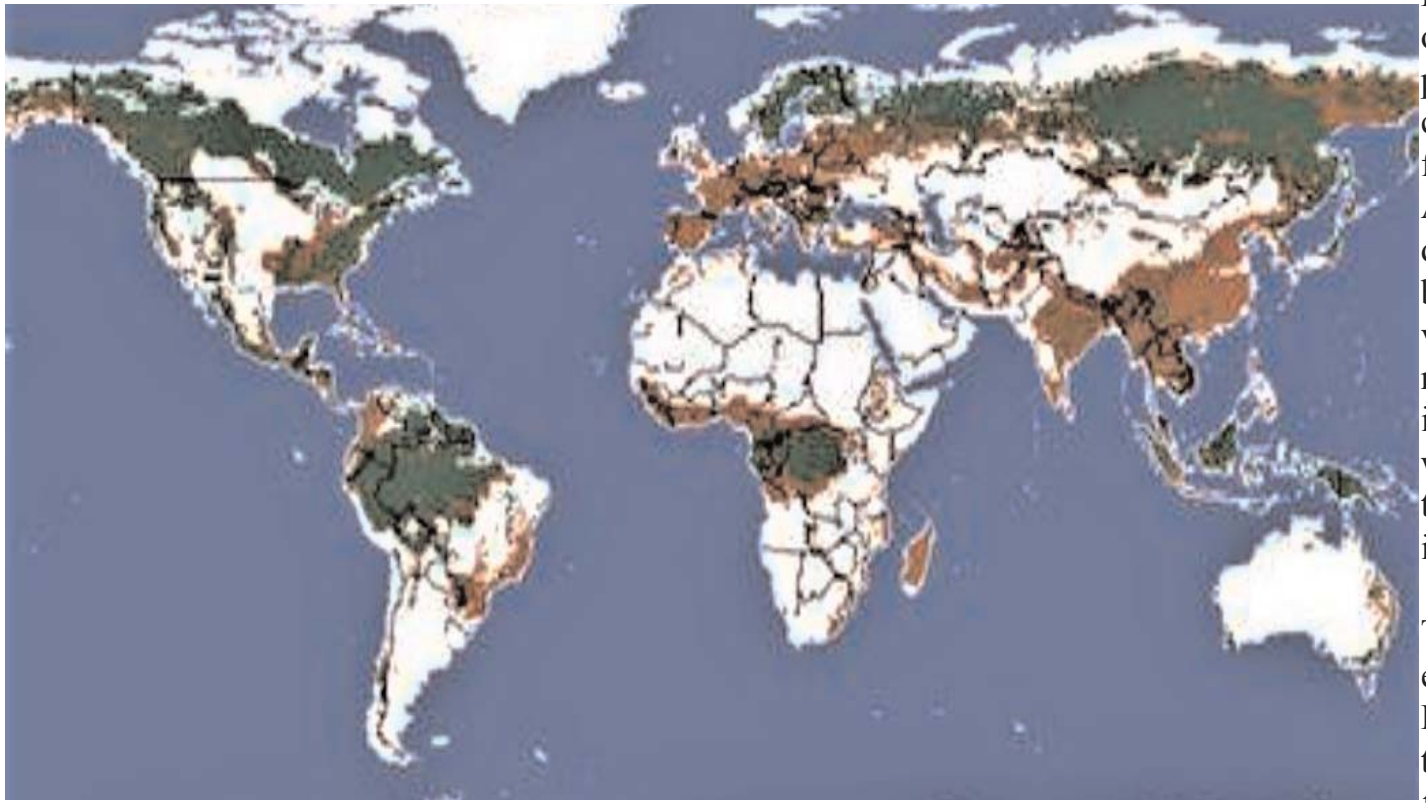
3 - Food specializations.
Bats are the main component of mammalian biodiversity in the Amazon; at least 50% of mammalian species are bats. Despite a superficially similar morphology, adaptations to at least seven diets allow them to co-exist: frugivores, aerial insectivores, gleaning insectivores, nectarivores, piscivores, sanguineivores, omnivores, gleaning animalivores, ...
Every year new species of mam-

mals are described from the Amazon and the Guianas, and not just mice or bats ("rats and bats"). During the period 1992 to 1998, 7 genera and 57 species new to science were discovered in the field or by studying specimens in museum collections. At the average rate of 8 species per year, in six different orders: certainly, rodents dominate (60%), in particular rats & mice (50%), but there were 4 marsupials, six primates, 3 insectivores, and 9 bats.

Most of these new species have been discovered in humid lowland forests (26 in the Amazon and in the Guianas) and in the mountains (12 in the Andes), and this in the majority of Central and South American countries. .

Forests are perhaps our best allies in the face of global warming. Because they absorb a significant part of the carbon dioxide (CO2) present in our atmosphere. But affirmation may soon have to come together in the past tense. Because with deforestation, forests - especially those in tropical regions - begin to release more CO2 than they store.

And that's not the only problem that deforestation poses to the climate. Far from it, we are learning today from researchers from the Alliance for the Development of Sustainable and Resilient Agricultural and Food Systems. They studied how deforestation in the tropics influences a range of biophysical factors. Factors such as albedo, wind patterns, local heat distribution and even cloud composition or water cycles.



Over the past five centuries, primary forests have been profoundly modified by various human activities. In green, the large blocks of forest still intact today. In red, altered forests (exploited, in operation, or simply disappeared...).

Factors which themselves have effects on the well-being of human societies, on poverty, on agriculture and on the capacity of the countries concerned to feed their populations.
All with the aim of providing political decision-makers with solid data on the benefits, particularly economic, of preventing deforestation. Because let us remember that some 1.6 billion people in the world depend directly on forests, whether for their food, for shelter, for their energy or to find remedies or income there.

The researchers were particularly interested in the local redistribution of heat. Because much like an umbrella allows the person holding it to stay dry, treetops know how to disperse heat. Distribute it to the heights. Without a forest, on the other hand, nothing pre-

vents the sun's rays from directly hitting the ground.

The researchers also analyzed the consequences of deforestation on the water cycle. Another factor they consider particularly important. Once the trees are cut down, the pump that transfers water from the surface to the air disappears. The precipitation regime changes.

It is also changing because forests are an important source of biogenic volatile organic compounds (BVOCs). These are involved in the formation of clouds. Less BOCs due to deforestation and you will have fewer water droplets in the clouds. Clouds which will thus also become less brilliant and will in fact reflect less solar energy towards space. Until then, researchers thought that the different biophysical effects compensated each other. But this new work shows on the contrary to what extent deforestation reduces the overall cooling effect of clouds.

Forests are invaluable to all life on earth
Forests cover 1/3 of the total land area
Forests contain most of the world's terrestrial biodiversity
1.6 billion people
depend on forests for their livelihoods
US$108 billion a year
of medicinal plants from tropical forests
The rate of deforestation, though slowing, is still alarmingly high
5.2 million hectares lost each year; equivalent to the size of a soccer field every second
A sustainable future for forests
Forests must be managed
Widespread forest restoration

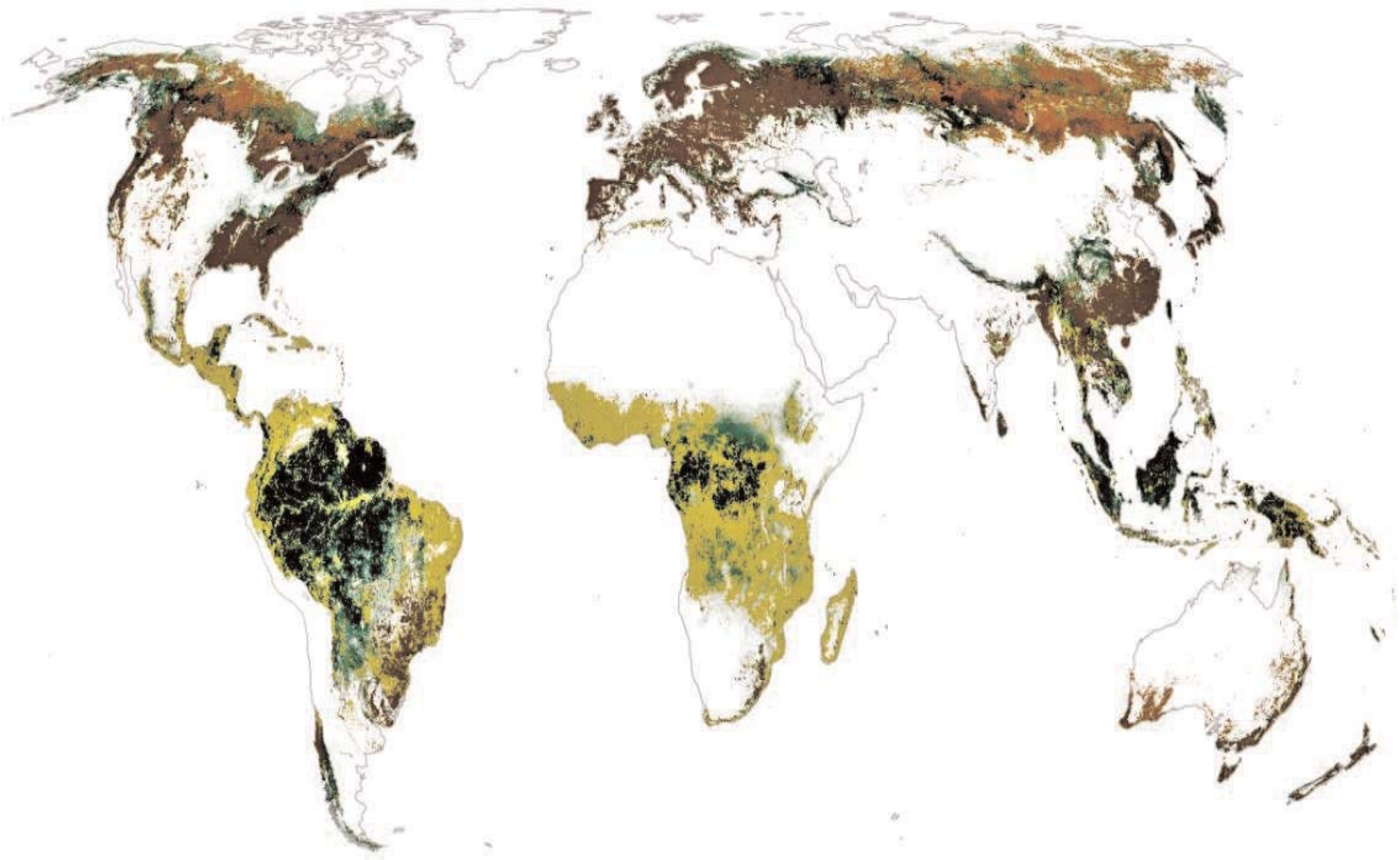
Forests yes, but natural forests

Thus the restoration of 350 million hectares of natural forests could make it possible to eliminate some 42 billion tonnes of carbon from the atmosphere by 2100. This remains little compared to the 730 billion tonnes that would be necessary to limit the global warming. Strict enforcement of state pledges - which include plantations in 45% of cases, restoration of natural forest in 34% of cases and agroforestry in 21% -, however, would reduce this figure further to 16 billion tonnes. If commercial monocultures were planted on the 350 million hectares, it would even fall to one billion tons.

"These differences can be explained, among other things, by the fact that the plantations are cut down every ten years or so, explains Charlotte Wheeler, researcher at the University of Edinburgh (Scotland). , however natural they may be, will not be enough on their own to achieve our climate goals. However, no scenario capable of containing global warming has been imagined without the large-scale restoration of natural forests. "

Areas affected by temporary forest loss 2001 2015

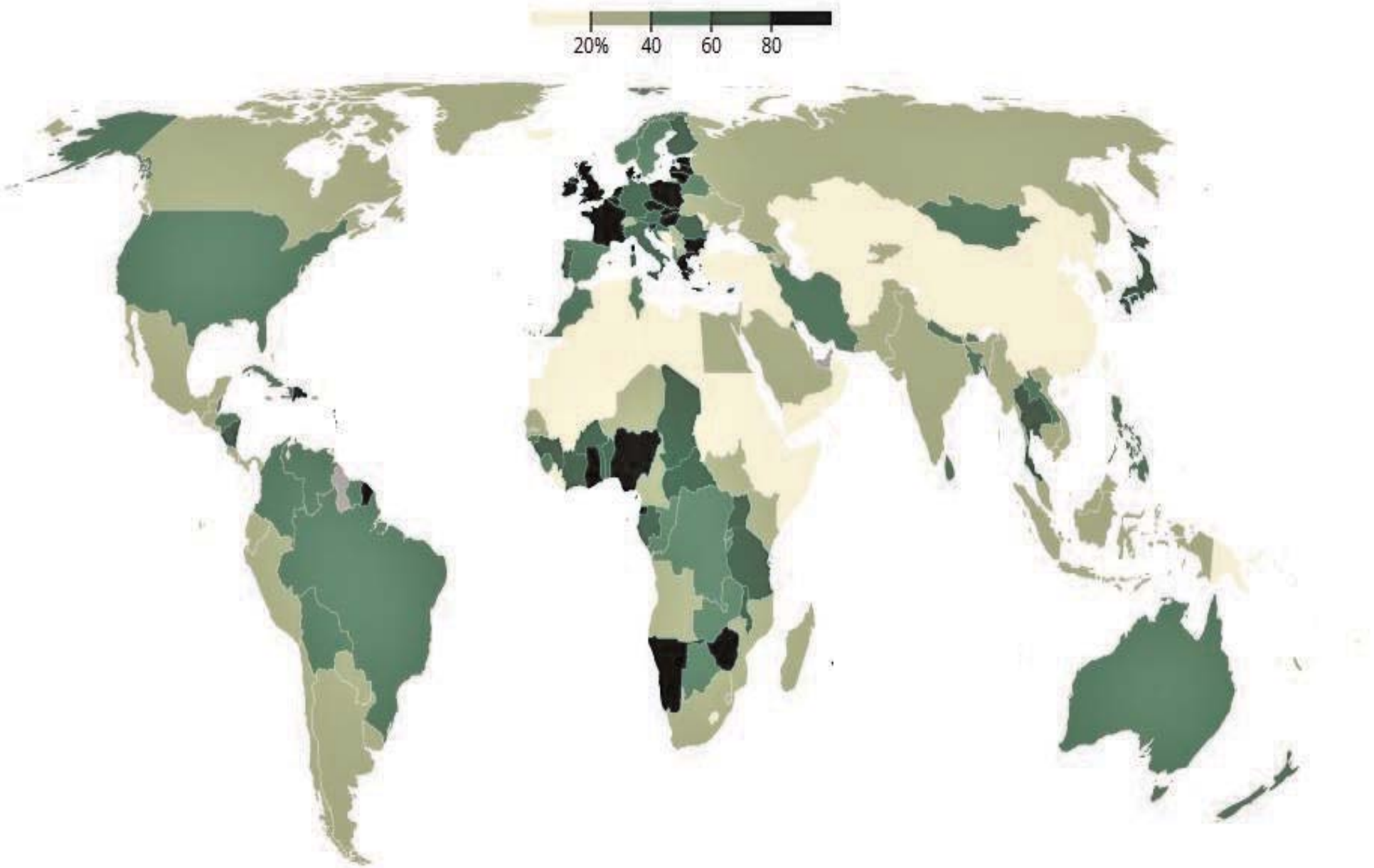
Shifting agriculture - forest fires - forestry



ources : P.G. Curtis, C.M. Slay, N.L. Harris, A. Tyukavina et M.C. Hansen (2018). « Classifying drivers of global forest loss ». *Science*, 361(6407), 1108-1111 ; Global Forest Watch.

Progress in protecting areas for biodiversity

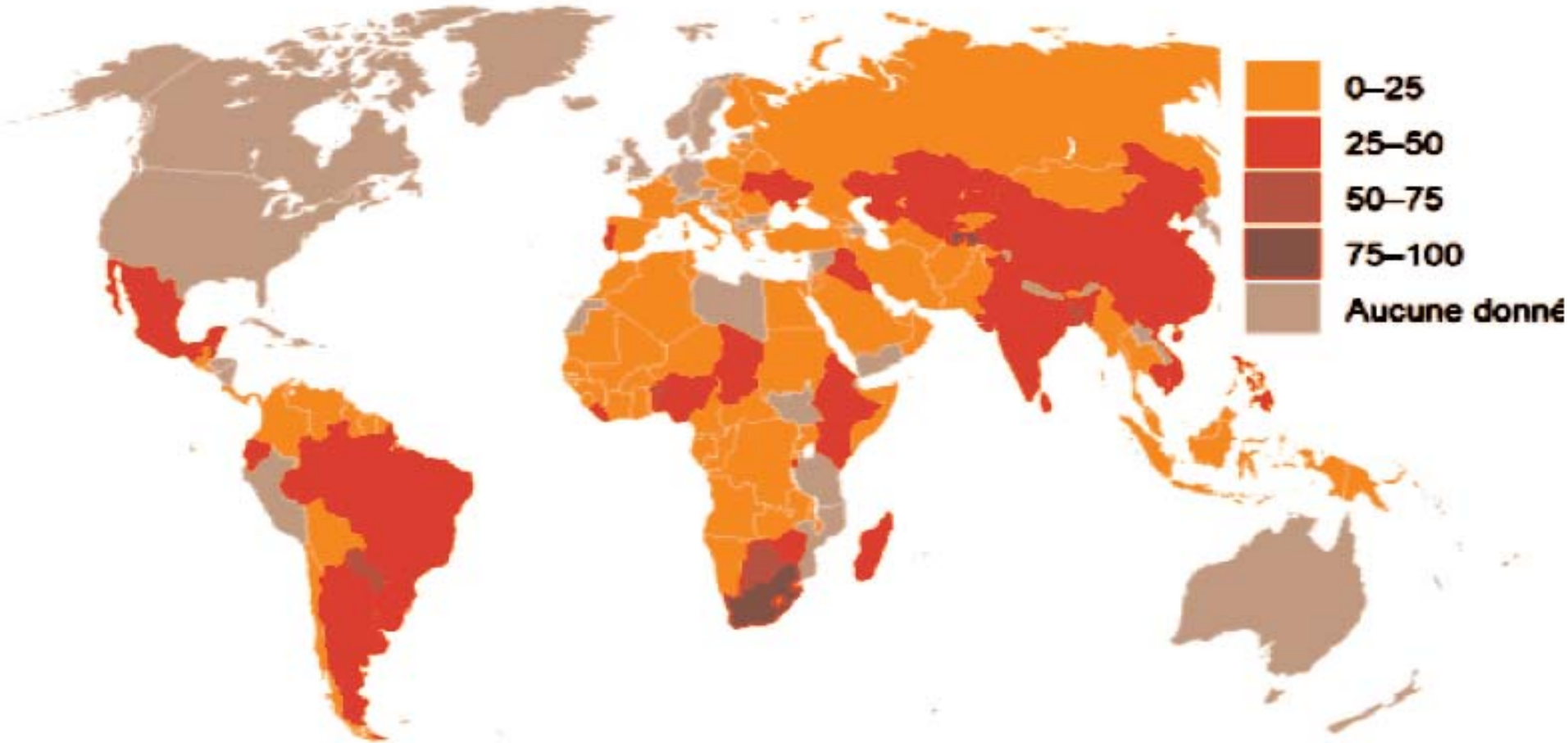
Average proportion of terrestrial key biodiversity areas covered by protected areas %



Land degradation affects all regions of the world

Degraded lands are those whose productivity and ecological or economic complexity are reduced

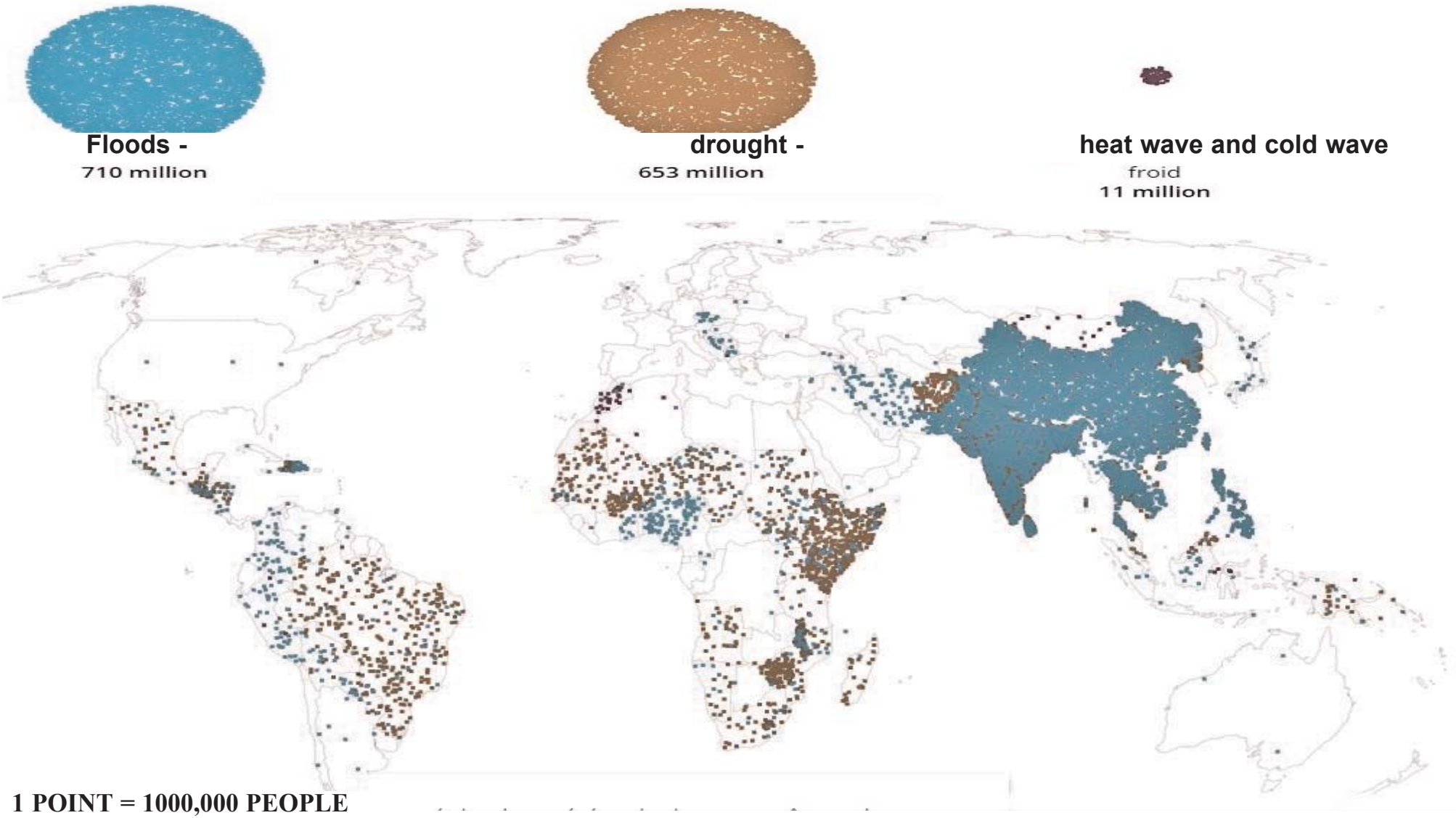
Proportion of degraded land 2015 (% of total land area



Floods, droughts and heat waves foreshadow climate change

The planet's climate is changing. The causes are well known: they are greenhouse gas (GHG) emissions resulting from human activities such as the use of fossil fuels for heating, electricity and transport, as well as industrial processes and changes in land use.

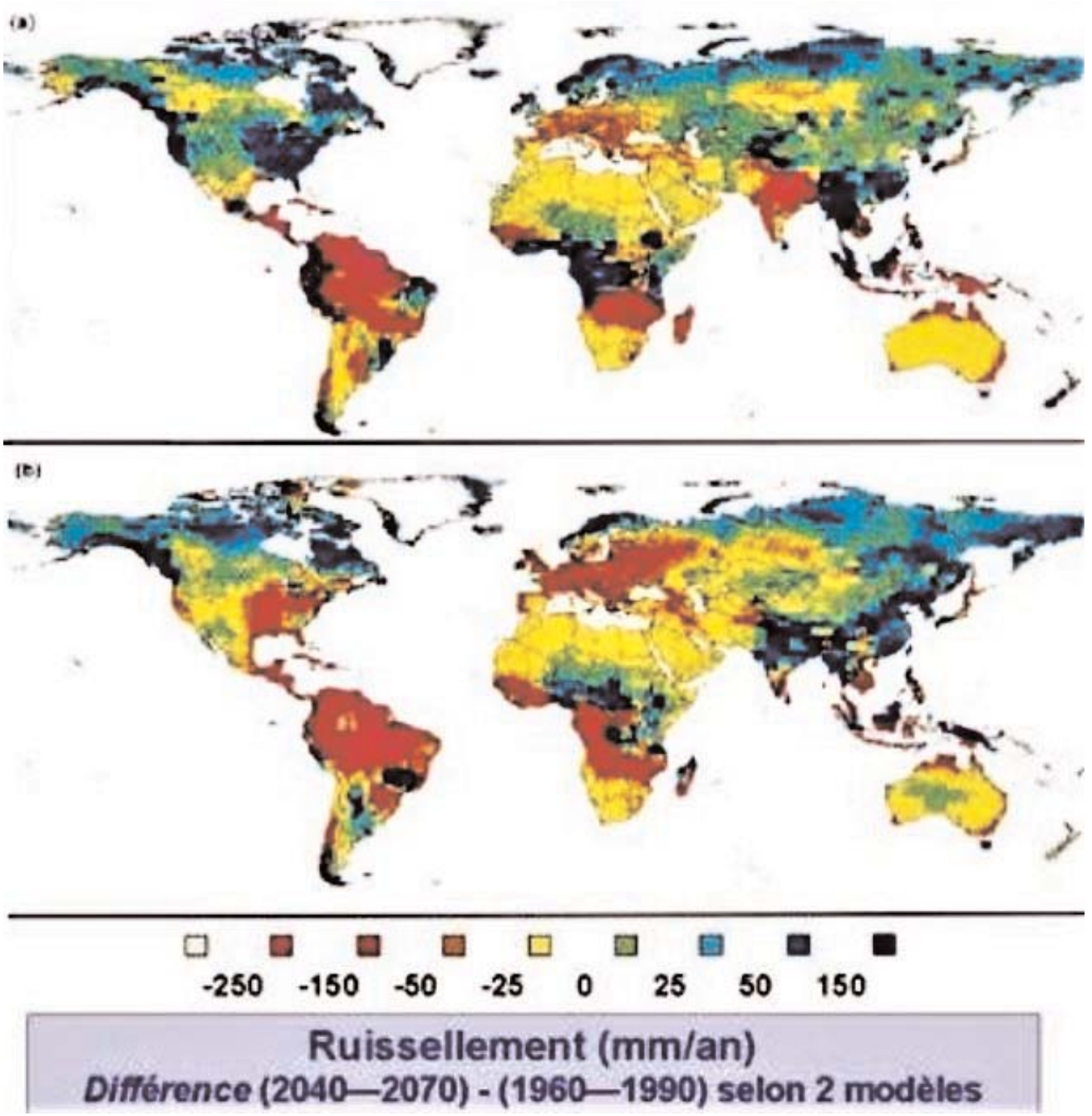
Climate change jeopardizes progress made in almost all areas of human development. It poses significant risks to food production, water supply, ecosystems, energy security and infrastructure. Such events are signs of a changing climate, and their frequency and intensity are increasing. By 2050, its worst effects are likely to force more than 140 million people to migrate within their countries.



Furthermore, what will become of the risks of flooding? This depends in many cases on rare episodes of particularly heavy precipitation, and in some cases the risk of severe flooding may increase even if the average precipitation decreases.

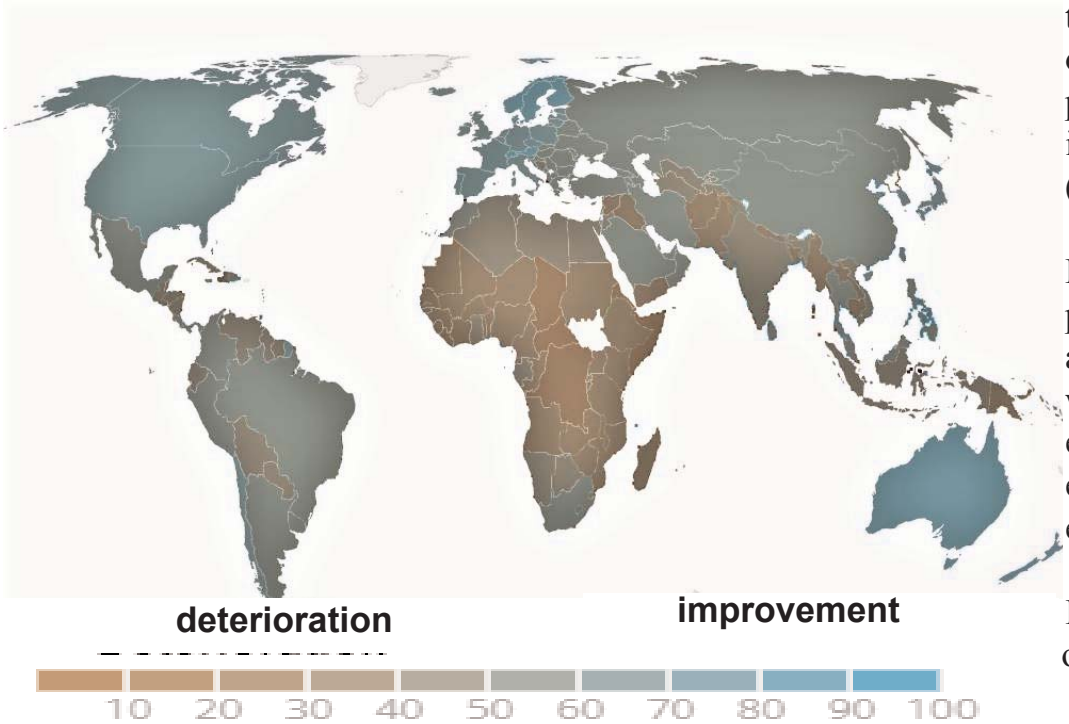
By evoking the possible changes in the runoff, we have entered into the complexity. It is certainly useful to begin the study of climatic processes in terms of solar irradiation, the parasol effect, and the greenhouse effect, all being considered as a global average (average over the surface of the globe, average over the 'year).

However, this remains an oversimplification. Climate is a matter of non-uniformly distributed solar energy fluxes across the globe, varying greatly with latitude, seasons, and time. These non-uniformities act as a motor for the circulation of the atmosphere, and the atmospheric movements set in motion the ocean currents, all these movements being affected by the Coriolis force due to the rotation of our planet. The unevenly distributed solar energy, absorbed and converted into heat especially in the tropics, is redistributed by the circulation of the atmosphere and the oceans towards less favored zones.



Increases and reductions in runoff (in mm/year). Forecasts for the middle of the 21st century, with two different models applied to the same atmospheric alteration scenario. According to the IPCC report (2001).

Floods and droughts have had the most serious human consequences. Climate change is expected to further increase the frequency and intensity of these phenomena. Extreme weather events like this disproportionately hit people in low-income and lower-middle-income countries. For example, in the past decade alone, droughts and floods have affected an estimated 338 million people in India and 383 million in China.



Low-income countries are not only more exposed than high-income countries to the adverse effects of climate change, but they are also less well equipped to deal with them.

This stark contrast is clearly reflected in the Global Adaptation Index compiled by Notre Dame University, shown here. Countries with the lowest scores are both more vulnerable to climate change and less prepared to adapt to it.

A future of uncertain extremes

The magnitude of future climate change will depend on net GHG emissions, which in turn depend on multiple factors: political choices, social and economic processes, technology. Given these uncertainties, climatologists use simulation models of the Earth's climate system to assess the effects of different scenarios.

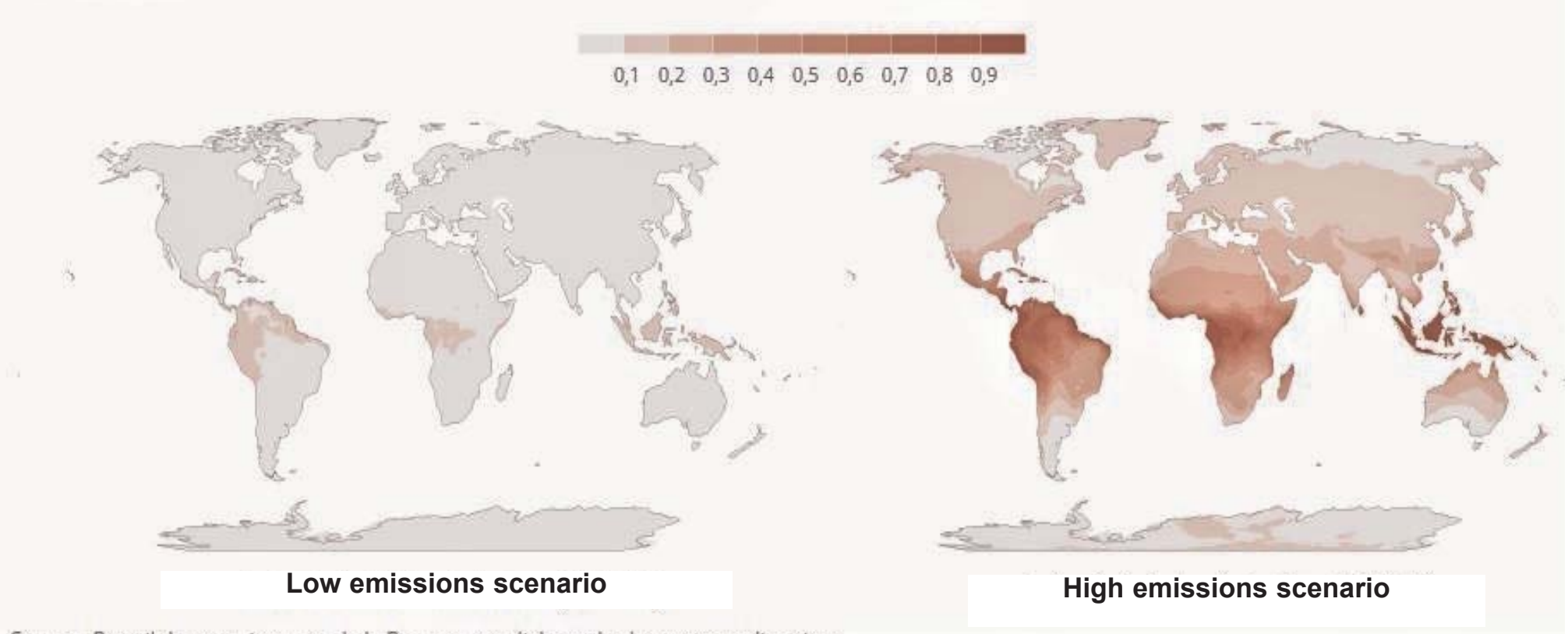
Four of these scenarios are commonly used. These are the "representative profiles of concentration evolution" (or RCP according to the English acronym). Even the most ambitious scenario in terms of emission reductions, RCP 2.6, predicts an average global temperature increase of 1.0°C by 2100 (±0.7). The RCP 8.5 scenario, in which emissions are the highest, predicts an increase of 3.7°C (±1.1) .

However, these temperature increases are averages for the entire planet and for an entire year, they do not reflect variations in time and space. As the climate warms, the likelihood of extreme weather events such as heat waves, floods and droughts is also expected to change. In many parts of the globe, especially the equatorial regions, the climate is becoming more erratic and extreme events will be more frequent and more severe.

It is also in these same regions that a disproportionate proportion of extremely poor people live.

By 2100, weather conditions that would have been considered a heat wave at the end of the 20th century will become normal.

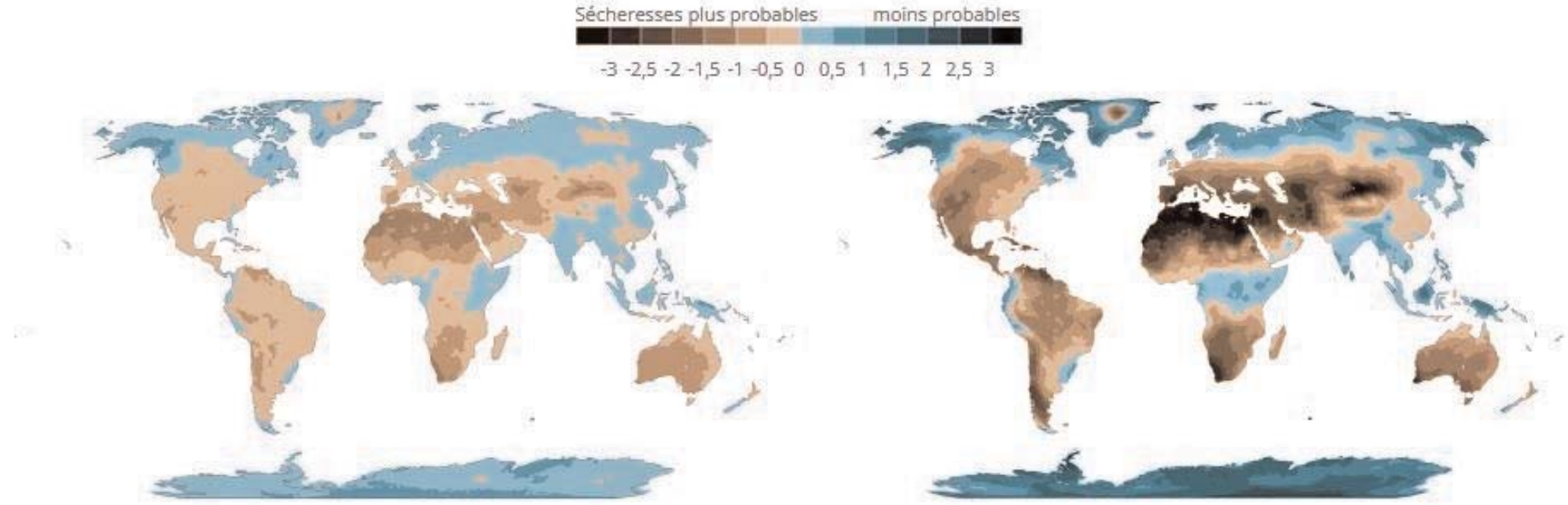
Hot spots will be more likely in equatorial regions


0,1 0,2 0,3 0,4 0,5 0,6 0,7 0,8 0,9
Low emissions scenario
High emissions scenario
Source : Portail de connaissances de la Banque mondiale sur le changement climatique.

Climate change will also affect the likelihood of drought. On our planet, water circulates in a loop between the atmosphere and the terrestrial environment. Thus precipitation (rain, hail or snow) transfers water from the atmosphere to the ground from where it can reach lakes, rivers and even the oceans. Then, evaporation from the ocean, soils and other surfaces and transpiration from plants complete this cycle, returning water vapor to the air.

Climate change will alter the balance of this cycle. One measure of this phenomenon is the normalized precipitation-evapotranspiration index, an index in which low values indicate more drought-prone conditions. Large regions of the planet, especially the mid-latitudes, are expected to be more exposed to drought by 2100.

Many regions will become more prone to drought, especially in mid-latitudes



Low emissions scenario

High emissions scenario

Source : Portail de connaissances de la Banque mondiale sur le changement climatique.

Climate action helps, but more needs to be done

No less than 197 countries signed the 2016 Paris Agreement, a coordinated global commitment to prevent the worst consequences of climate change through mitigation measures, adaptation strategies and financing. The signatories adopted a long-term goal to limit the rise in global temperature to less than 2°C above pre- industrial levels. They also agreed to continue efforts to further contain the temperature increase to 1.5°C.

States parties to the convention have committed to take climate action in the form of "Nationally Determined Contributions (NDCs)". These are categorized according to whether they relate primarily to adaptation or mitigation. Adaptation pledges aim to address the negative effects of climate change, while mitigation pledges aim to reduce GHG emissions. These commitments are reinforced by SDG target 13.2, which calls on countries to incorporate climate change actions into their national policies, strategies and planning activities.

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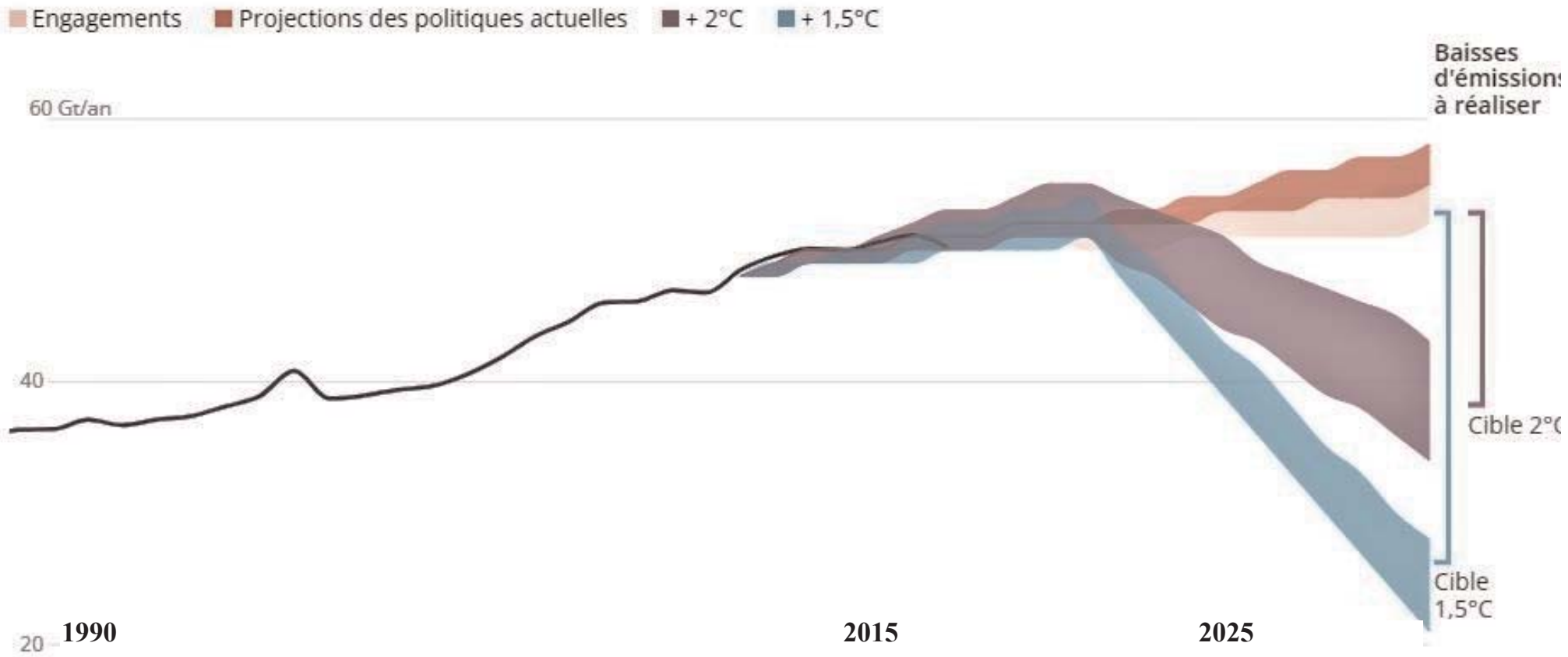
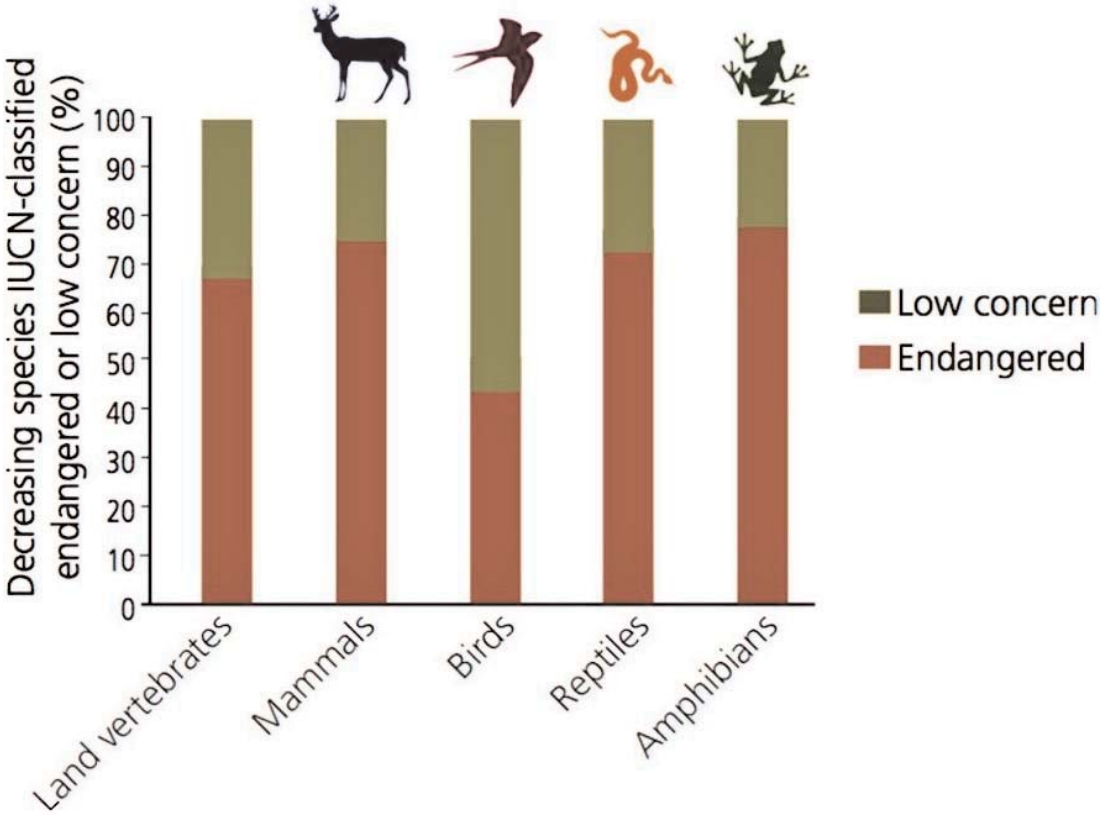
Not only are the projected emission reductions modest over the long term, but the current commitments are insufficient to meet the goals of the Paris Agreement. Even the easier-to-achieve 2°C target would require immediate and drastic reductions in GHG emissions. Without a long-term solution to climate change, there can be no sustainable development. However, the growing gap between projected emissions and the trajectories needed to reach the 1.5°C or 2°C objectives threatens the most vulnerable inhabitants of the planet.

Current mitigation commitments fall short of global goals



WHICH CHANGE FOR THE FUTURE ?

Recently, in an article published in Nature Geoscience, researchers who were interested in one of the climate warmings of the past observed a collapse of marine and terrestrial ecosystems (multiplication of dead zones in the ocean, deforestation...) during an increase in temperature between 4 and 7°C. "Our study shows that rapid global warming can have both major and long-lasting impacts on land and in the sea," explained Richard Twitchett, research director at the Museum of Natural History in London, who participated in the study. this study on the beginning of the Jurassic, 183 million years ago. Several tens of millennia were needed for nature to recover.



The percentage of species in decline classified by the IUCN as "endangered", endangered, (including "critically endangered", "endangered", "vulnerable", and "near threatened") or "low concern" in terrestrial vertebrates. This figure highlights that even species that have not yet been classified as endangered (about 30% in the case of all vertebrates) are in decline. This situation is even more critical for birds, of which nearly 55% of the species in decline are still classified in the "little concern" category. © Pnas

The Earth has already faced several mass extinctions. That of the Permian-Trias, 250 million years ago, thus eradicated nearly 95% of marine life and 70% of terrestrial species. But the losses caused by humans are far too rapid to allow evolution to restore the lost biodiversity, believe the authors of the study. The latter sought to assess how long it would take to return to the level of biodiversity prior to the Anthropocene era for mammals.

For 130,000 years, more than 2.5 million species have been wiped off the surface of the planet, including 500,000 in the last 1,500 years alone. A massive extinction that primarily concerns wild mammals. Man has wiped entire branches of large mammals off the surface of the planet. : 83% of them have already disappeared, according to a previous study in 2018. And nearly a quarter of species are now threatened, of which 199 are in "critical" danger, according to the red list of IUCN (International Union for Conservation of Nature)

Up to 7 million years to return to pre-Anthropocene biodiversity

In the best case, that is to say if no more species of mammal disappeared from today, it would take 500,000 years to return to the same level of biodiversity as before the arrival of Man. , according to the calculations of scientists. Unfortunately, this is not the most likely hypothesis. In the most likely case, where extinctions continue at the current rate for another 50 years, this reconstruction could take 5 to 7 million years, including 3 to 5 million just to restore the biodiversity lost dur-

ing this time. Because, even taking into account the appearance of new species, natural in the process of evolution, the destruction caused by Man is far too rapid to be compensated.

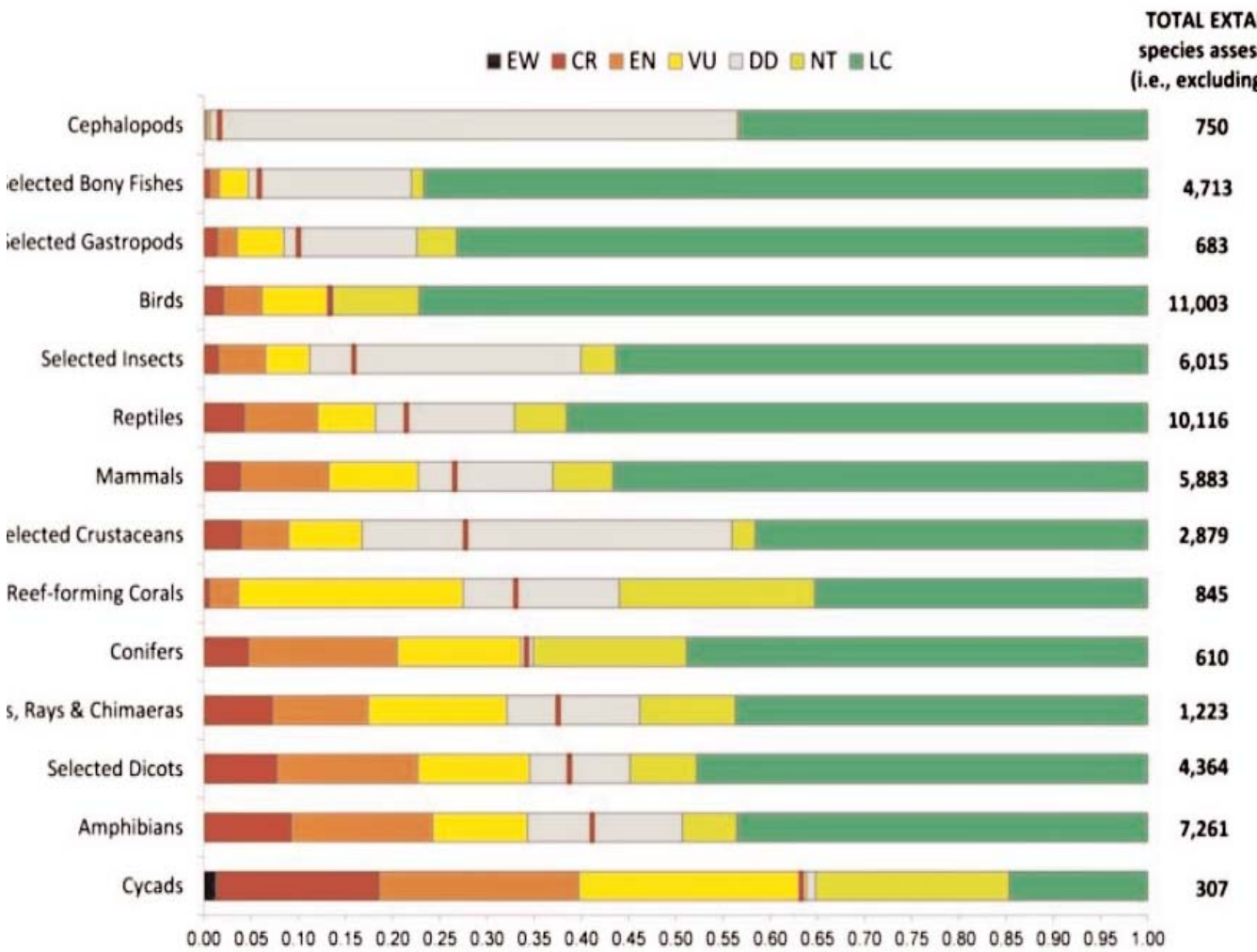
While the mapping of species threatened with imminent extinction is superimposed on that of regions rich in biodiversity and greatly impacted by human activity (subtropical areas in the first line), species with between 1,000 and 5,000 individuals have a geographical distribution well more global. There is also overlap between these species and those most threatened, suggesting that the imminent disappearance of one causes the weakening of the others. "Extinction breeds extinctions," the researchers comment.

Today, the rate of extinction of species is several hundred or even several thousand times higher than the normal rate. "Instead of nine expected extinctions [between 1900 and 2050], 1,058 species will be extinct in 2050, writes the team. The species that will become extinct during these 150 years would have taken 11,700 years to disappear with a natural rate of 'extinction ". According to a recent United Nations report, a quarter of the species on Earth are threatened with imminent extinction, most of them set to occur within the next few decades.

The three authors emphasize that they did not want to focus exclusively on endangered species. Indeed, this approach is, for them, misleading because it "can give the impression that terrestrial biota are not immediately threatened but are just slowly entering a major episode of biodiversity loss". The researchers preferred to measure the contractions of their populations, whether for the most threatened identified by the IUCN, as for those called "common" and "little concerned", because, they recall, "[...] disappearance of populations is a prelude to that of species.

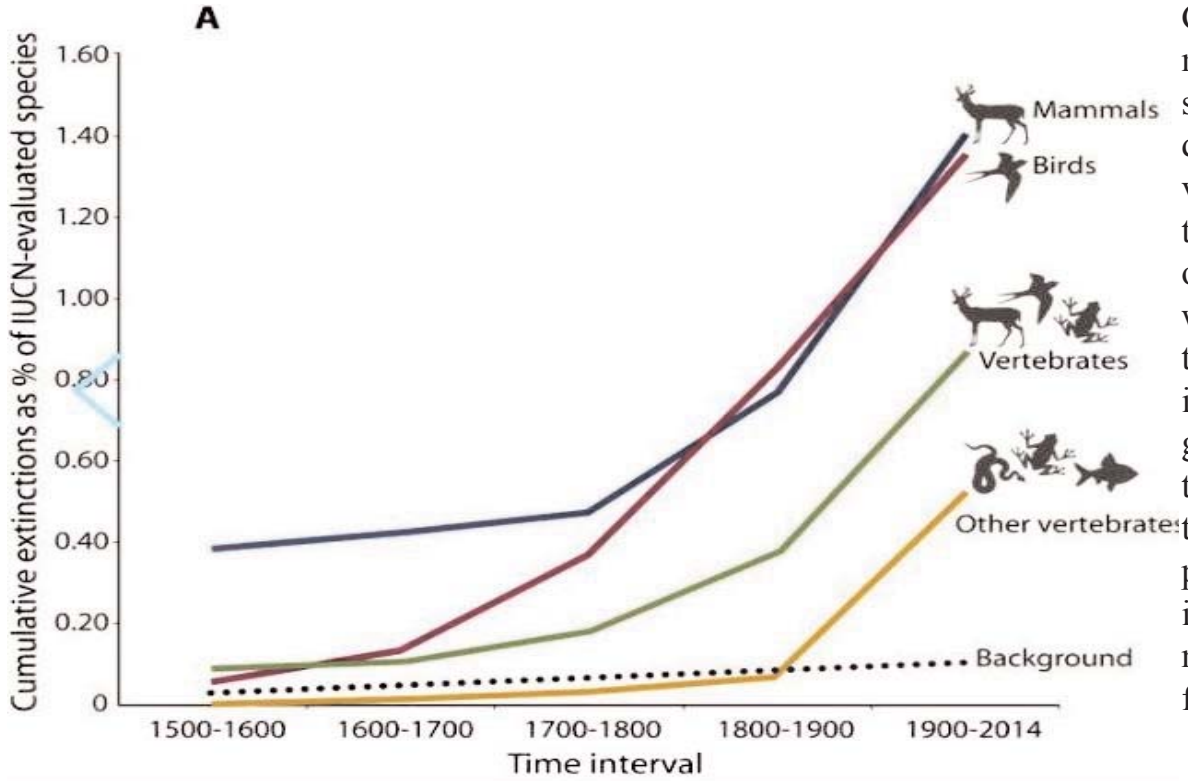
Thus they found that a third, 32% (precisely 8,851 out of 27,600), of the species they studied, which represent about half of all those known, are in decline. And this, both in numbers and in areas of distribution. As for the sample of 177 mammals that the researchers say they have detailed data, the results show that all have lost 30% or more of their territories and more than 40% have suffered severe population declines. .

Among the most representative examples are the cheetahs, which number only 7,000 today (against 100,000 in 1900). Lions too: 25 years ago, they were 43% more numerous..., now there are only 35,000... And needless to say how many kingdoms this animal has lost in the space of a few centuries . The great apes are also in decline, several of which, like the orangutan, are "critically endangered", the last stage before extinction. A study published on July 7 in Scientific Reports estimates that in Borneo, their population has fallen by 25% in just ten years. They were still 288,500 in 1973 and could be no more than 47,000 in 2025, if nothing is done to stop their habitat loss and slaughter (up to 2,500 orangutans are killed each year).

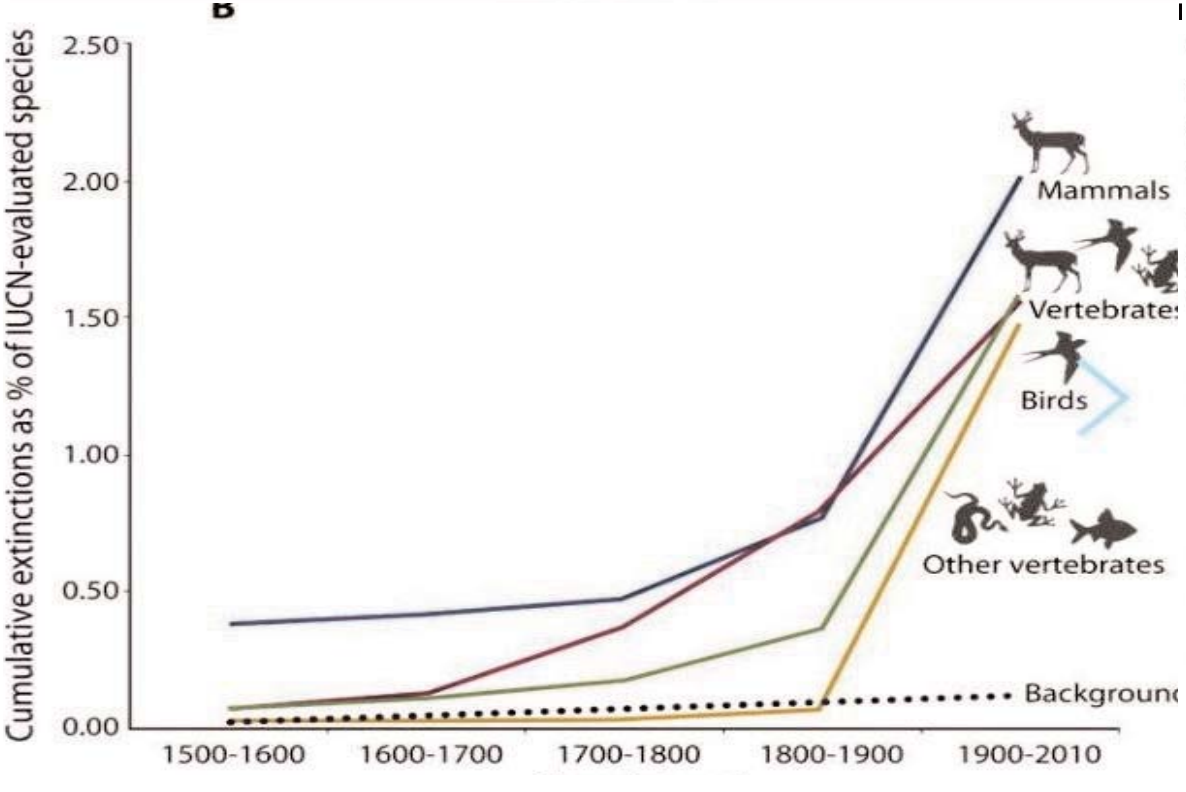

EW CR EN VU DD NT LC
TOTAL EXTANT species assessed (i.e., excluding EX)
Cephalopods 750
elected Bony Fishes 4,713
elected Gastropods 683
Birds 11,003
Selected Insects 6,015
Reptiles 10,116
Mammals 5,883
elected Crustaceans 2,879
Reef-forming Corals 845
Conifers 610
s, Rays & Chimaeras 1,223
Selected Dicots 4,364
Amphibians 7,261
Cycads 307
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00

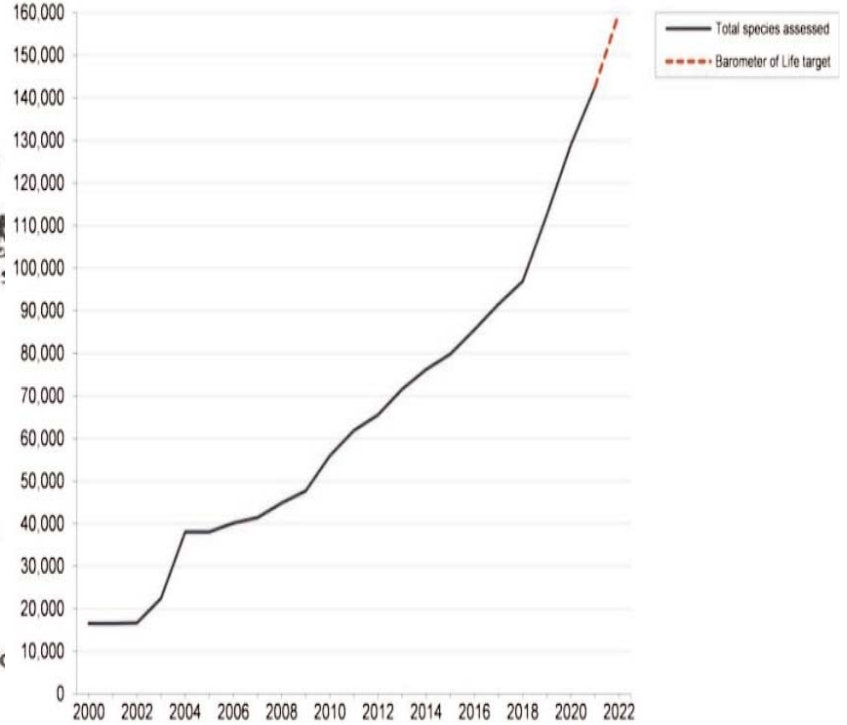
The proportion of extant species (i.e. excluding extinct species) in the IUCN Red List of Threatened Species. Version 2021-3 assessed in each category for groups assessed more thoroughly (i.e. at least 80% of the group assessed) containing = 150 species. Species are grouped into classes (with the exception of reef-forming corals, which include species in the classes Hydrozoa and Anthozoa), and are ranked according to the vertical red lines, which indicate the best estimate of the proportion of extant species considered as threatened (CR, FR or VU). The best estimates of the percentage of threatened species (with lower and upper estimates) for each group are: cycads 63% (63-64%); amphibians 41% (34-51%); selected broadleaf weeds (birch, cactus, magnolia, maple, oak, protea family, southern beech, tea) 39% (34-45%); sharks, rays & chimaeras 37% (32-46%); conifers 34% (34-35%); reef-forming corals 33% (27-44%); selected crustaceans (lobster, freshwater crab, freshwater crayfish, freshwater shrimp) 28% (17-56%); mammals 26% (23-37%); reptiles 21% (18-33%); selected insects (dragonflies and damselflies) 16% (11-40%); birds 13% (13-14%); selected gastropods (abalone, cone snails) 10% (8-23%); selected bony fishes (anchovies, herrings, sardines and relatives; angelfish; billfishes; blennies; bonefishes; butterflyfishes; cornetfishes; croakers and drumfishes; dragonfishes, lightfishes and relatives; filefishes; ghost pipefishes; groupers gulpers, snipes and relatives; trevallies, pompanos and relatives; ladybugs; lanternfish; lizardfish and allies; pufferfish; sea bream, sea bream and picarelle; seahorses, pipefish and relatives; shrimps; sturgeons; surgeonfish, tangs and unicornfish; swordfish; tarpon; trumpetfish; tuna; wrasse) 6% (5-22%); cephalopods (nautilus, octopus, squid) 1.5% (1-57%).

The numbers to the right of each bar represent the total number of extant species assessed for each group. EW - Extinct in the Wild, EN - Endangered, VU - Vulnerable, NT - Near Threatened, DD - Data Deficient, LC - Least Concern.



Gradually, ecosystems come to a standstill, unable to maintain the subtle balance that only the diversity and specialization of species can guarantee. From the destruction of these fragile species, necessary for our survival, to the current health crisis potentially linked to the trafficking and consumption of wild animals, "this crisis of extinction, like the crises of pollution and climate to which it is linked, confronts civilization with an existential threat, the researchers say. Its magnitude and likely impacts on human well-being are largely unknown to governments, the private sector and civil society." It is therefore, according to them, for the scientific community to take the necessary measures to inform the entities in power and the public, and to stem the extinction before it is too late. "We can still act, but the window of opportunity is almost closed. We must salvage what we can, or forever lose the chance to do so."





Trends and challenges for the future

ENVIRONMENT

Four key markers of climate change broke new records in 2021, the UN said on Wednesday, warning that the global energy system is driving humanity into catastrophe.

Greenhouse gas concentrations, sea level rise, temperature and ocean acidification all set new records last year, the World Meteorological Organization (WMO) said in its State of the global climate in 2021.

The report is a lamentable litany of humanity's failure to tackle climate change, said UN chief Antonio Guterres.

The global energy system is broken and bringing us ever closer to climate catastrophe, Guterres added, urging to end fossil fuel pollution and accelerate the transition to renewable energy before burning our only home .

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The WMO said human activity is causing changes on a planetary scale: on land, in the ocean and in the atmosphere, with harmful and long-lasting ramifications for ecosystems.

The report confirmed that the past seven years were the seven hottest years on record. La Nina-related weather events in early and late 2021 had a chilling effect on global temperatures last year. But despite this, 2021 remains one of the hottest years on record, with the average global temperature around 1.11°C above pre-industrial levels. The 2015 Paris Climate Agreement aims to limit global warming to +1.5°C compared to pre-industrial times.

Our climate is changing before our eyes, said WMO chief Petteri Taalas. Heat trapped by human-made greenhouse gases will warm the planet for many generations to come. Sea level rise, heat and ocean acidification will continue for hundreds of years unless ways to remove carbon from the atmosphere are invented.

Four key indicators of climate change build a cohesive picture of a warming world that affects all parts of the planet, the report says.

Greenhouse gas concentrations reached a new global high in 2020, when carbon dioxide (CO_2) concentration reached 413.2 parts per million (ppm) globally, or 149% of pre-industrial levels.

The data indicates that they continued to increase in 2021 and early 2022, with the average monthly CO_2 concentration at Mona Loa in Hawaii reaching 416.45 ppm in April 2020, 419.05 ppm in April 2021 and 420.23 ppm in April 2022, according to the report.

Global mean sea level hit a new record high in 2021, after rising an average of 4.5 millimeters per year from 2013 to 2021, the report said.

It had shown an average increase of 2.1 mm per year between 1993 and 2002, the increase between the two periods being mainly due to

the accelerated loss of ice mass from the ice sheets, underlines the document.

Ocean temperature also hit a record high last year, surpassing the 2020 value, according to the report. It is expected that the top 2000 meters of ocean depth will continue to warm in the future. An irreversible change on timescales of centuries to millennia, the WMO said, adding that heat was penetrating ever deeper.

The ocean absorbs about 23% of annual man-made CO2 emissions into the atmosphere. Although this slows the increase in atmospheric CO2 concentrations, the latter reacts with seawater and leads to ocean acidification.

Meanwhile, the report reveals that the Antarctic ozone hole is unusually deep and extended by 24.8 million square kilometers in 2021, driven by a strong and stable polar vortex.

HEALTH
Environmental change and degradation are accompanied by increasing health risks. Climate change, the depletion of the ozone layer, the loss of biological diversity, the degradation of ecosystems and the spread of resistant organic pollutants are all environmental threats that weigh globally on health in the world.
Climate change will have effects on health that are beginning to be perceptible, even if elements of uncertainty remain.

The development of many disease transmission vectors (such as mosquitoes, parasites, etc.) are sensitive to ambient temperatures and will see their intensity and range of transmission increase. Changes in rainfall, and subsequently the distribution of surface water and humidity will have effects on the distribution and survivability of mosquitoes. Diseases such as dengue fever, certain encephalitis and tropical fevers, but also malaria (malaria already kills a million people a year), are set to increase sharply, particularly in tropical countries.

The food supply could be greatly modified, both due to a change in the distribution of agricultural resources, but also due to a weakening of the security of the supply chain, by the potential acceleration of the development of bacteria and micro-organisms in food production chains, favored by the increase in temperature.

The risk of natural disasters is increasing: the predicted rise in sea levels and the foreseeable increase in the frequency and intensity of extreme weather events (tornadoes, typhoons, floods, drought), will cause damage both on human settlements, economic activities, and human lives.
It is the poor who constitute the population most exposed and most vulnerable to the negative effects of climate change, in the countries of the South, but also of the North.

The marketing of products harmful to health, facilitated by economic globalization, raises a growing problem: in particular, the development of the trade in foodstuffs raises urgently the question of the safety of food products (in relation to chemical substances and micro-organisms) and the risks of spreading food-borne diseases (BSE). The application of biotechnologies to the food sector raises concerns. The industrial use of toxic and dangerous substances, or even their integration into everyday consumer products, construction, are also likely to cause long-term health deterioration (asbestos, solvents, etc.)

The aging of the world population (by 2025, people over 65 will represent 10% of the world's population and could increase by up to 300% in certain developed countries), accompanied by new needs in terms of long-term chronic disease care and undermining the financial sustainability of health systems.

Global warming will make many parts of the world uninhabitable and it has already started

With global warming, models predict the emergence, in some places of the globe, of unsustainable heat and humidity conditions by the middle of this 21st century. But new work shows that such conditions have already been recorded since 1979. The theoretical human survival limit of 35°C humid has even already been reached several times.

Under the effect of global warming, one to three billion human beings could be forced to live in unbearable heat within 50 years. But researchers at Columbia University (United States) are now pointing to a factor that could well aggravate the already critical situation a little more: humidity.

Humidity compounds the effects of heat, because it is by sweating - expelling water through the skin - that humans regulate their body temperature in hot weather. But in humid regions, the evaporation of sweat is slowed down. If the process went so far as to stop, the body would risk overheating. Including when it is healthy and can be hydrated properly.

At the end of 2017, a study warned of the fact that, in certain regions of the globe - the tropical and subtropical regions - the humidity could reach, over the next few decades, levels such that it would become difficult to work there. . And even, in some cases, to survive it. Thousands of rare or unprecedented episodes of heat and humidity have already occurred in Asia as well as in Africa, South America and North America.

By analyzing meteorological data from nearly 8,000 stations over the period 1979-2017 -- hourly data to identify short phenomena -- the researchers found that episodes combining extreme heat and humidity have doubled. Unsurprisingly, such episodes are concentrated on the coasts, along the seas, gulfs and straits. Further inland, monsoon winds or large areas of irrigation can sometimes produce the same effect.

Pollution still causes 9 million premature deaths worldwide

Pollution was responsible for the premature death of 9 million people in 2019, according to a study published in the journal The Lancet, a toll that is not improving, mainly due to poor air quality and chemical pollutants , especially lead.

Four years after a first report, the situation has not changed: about one in six premature deaths in the world is linked to pollution, deplores the Lancet Commission on Pollution and Health.

Pollution and waste created by humans released into the air, water and soil rarely kill directly, but cause serious heart disease, cancer, respiratory problems or acute diarrhoea.

The health effects remain enormous, and low- and middle-income countries are bearing the brunt of them, summarizes lead author and co-director of the commission Richard Fuller.

They account for 92% of these deaths and most of the resulting economic losses.

Attention and funding have increased only marginally since 2015, despite a well-documented increase in public concern about pollution and its health effects, he laments, quoted in a statement.

A factor almost as deadly as tobacco
While premature deaths linked to the types of pollution associated with extreme poverty are falling, those linked to air pollution and pollution by chemical products are increasing.

"The effect of pollution on health is still far greater than that of war, terrorism, malaria, HIV, tuberculosis, drugs and alcohol, and the number of deaths caused by pollution rivals that caused by tobacco."

- A quote from Excerpt from press release

In 2019, 6.7 million premature deaths were attributable to air pollution, 1.4 million to water pollution, 900,000 to lead poisoning.

The fact that the lead situation is getting worse, mainly in these poorer countries, and accelerating in terms of the number of deaths, is horrifying, Fuller told AFP.

Exposure to the toxic substance can also cause delays in the cognitive development of children.

While mortality linked to pollution within the household (linked to the combustion of fuels or to water or hygiene problems) has declined, particularly in Africa, modern forms of pollution weigh far more than there is. 20 years. In 2000, premature deaths linked to ambient air pollution amounted to 2.9 million, and 4.5 million in 2019.

Fine particles and ozone in the air, exposure to lead, carcinogens in the context of his work, chemical pollution in the environment are gaining ground, especially in Asia.

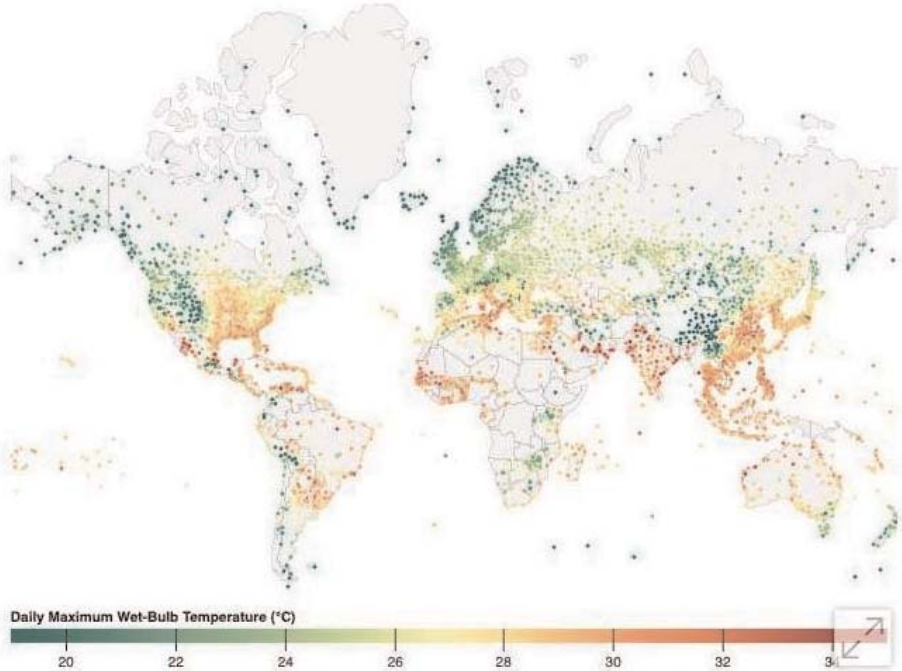
If we fail to develop in a clean and green way, then what we are doing is terribly wrong, Fuller told AFP.

Regions soon to be uninhabitable

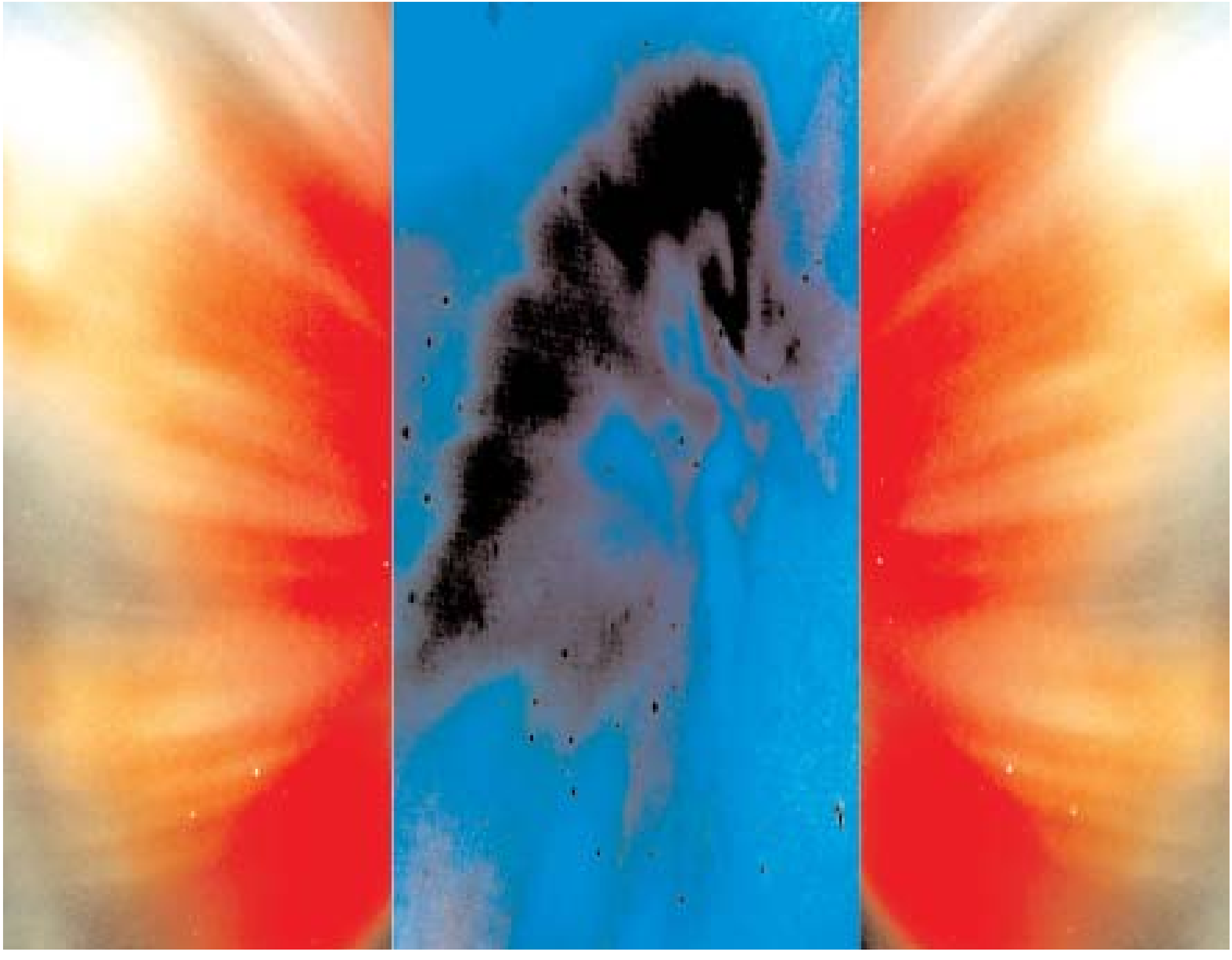
Meteorologists measure the combined heat/humidity effect on a so-called wet bulb temperature scale. The most resistant people can continue to evolve in the open air up to a humid temperature of 32°C, but the value of 35°C is considered as a theoretical limit of survival. However, the work of researchers at Columbia University shows that between 1979 and 2017, a wet temperature of 30°C, hitherto considered rare, has already been reached around a thousand times?! The temperature of 33°C, which the researchers thought was out of reach, was recorded 80 times.

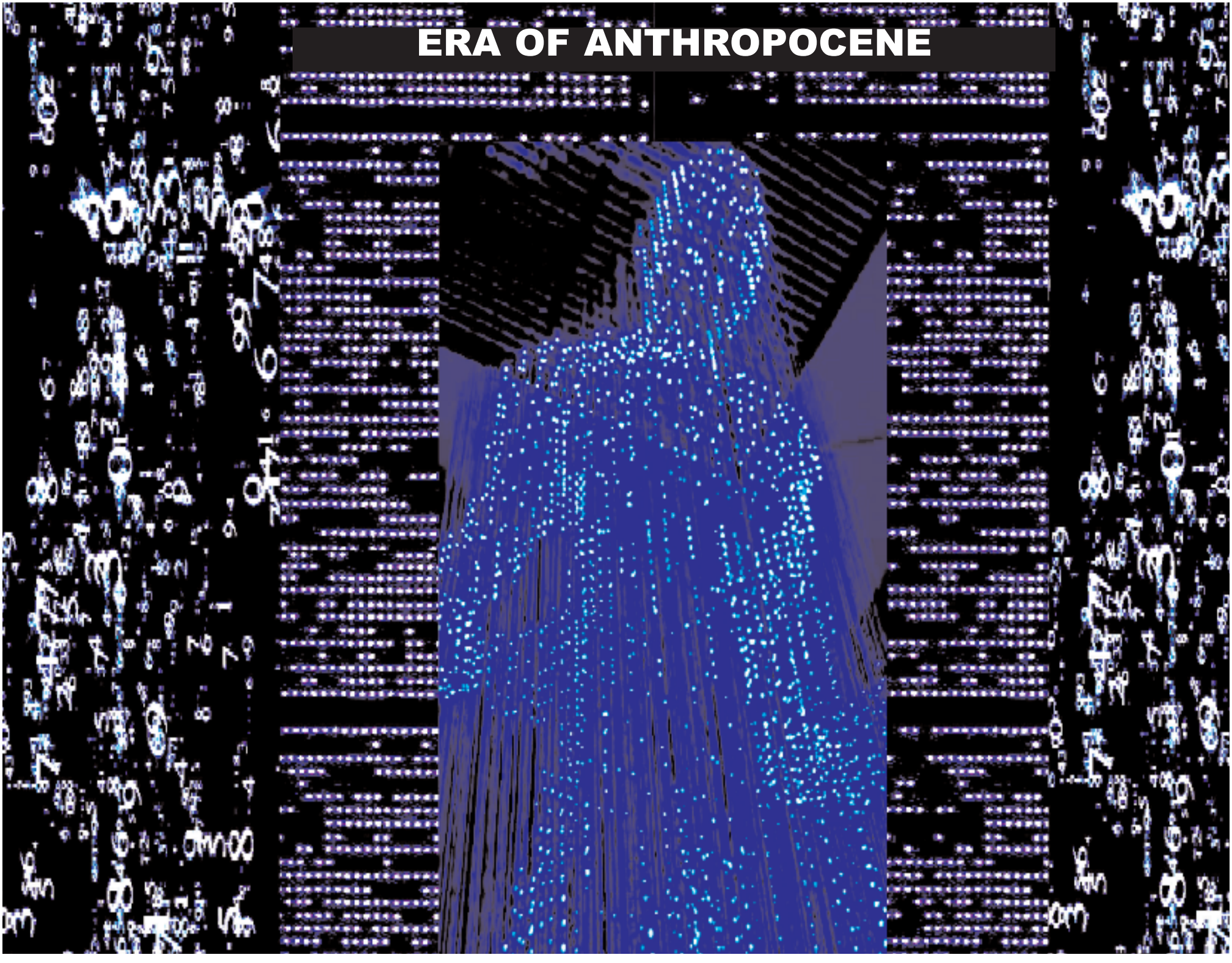
"We may be closer to a true tipping point than we thought," Radley Horton, one of the study's authors, warned in the statement. Especially since weather stations do not necessarily record the most sensitive points in a region. A situation that could - a bit like the one we are currently experiencing for another reason - literally stop economies by confining populations to the shelter of buildings. A situation that could also really endanger the health of these populations.

During the heat wave that hit the United States in July 2019, the wet temperature rose to 30°C. Entire communities were paralyzed and the episode claimed at least half a dozen lives. Another survey found that heat and humidity-related deaths among U.S. troops -- on domestic bases -- have already increased by 60% between 2008 and 2018. "The worst-affected regions could become uninhabitable" , concludes Radley Horton.



On the Persian Gulf side, about fifteen episodes of heat and humidity reached critical thresholds for human survival. Wet bulb temperature of 35 C with a felt humidity of 74 C (2015)




ERA OF ANTHROPOCENE

NEWS FROM THE ANTHROPOCENE

Following the Holocene (12,000 years since the last glaciation), the Anthropocene, the name given to a new geological epoch on the initiative of the chemist Paul Crutzen , is marked by the predominance of human beings over the system- earth. The concept of the Anthropocene is a brilliant way of renaming certain achievements of earth-system science. He points out that the geochemical processes that humanity has set in motion have such an inertia that the earth is in the process of leaving the ecological balance that prevailed during the Holocene. Historically, this war against nature marks the beginning of the Anthropocene. The human race has become a global geological force and the Anthropocene designates a point of no return ; a geological bifurcation in the history of planet Earth. If we don't know exactly what the Anthropocene has in store for us (earth-system simulations are uncertain), we can no longer doubt that something of geologic timescale significance has recently taken place on Earth. The thesis of the Anthropocene is based primarily on the phenomenal quantities of materials mobilized and emitted by humanity during the 19th and 20th centuries. Usually, geologists determine eras long after they have ended. The Anthropocene is now and it determines the future. This geological era is a bearer of the future, that is its originality. What is at stake with the Anthropocene is a change in the regime of thought. Land that allows us to consider a geography, landscapes, a climate, diseases, in short, a whole new speculative arsenal.

The Anthropocene thesis essentially tells us that the traces of our industrial age will remain for millions of years in the geological records of the planet. The opening of a new epoch tailored to human beings means that it is only on the scale of geological time that we can identify events acting with as much force on the planet as ourselves . : the level of carbon dioxide in 2015 is unprecedented for three million years, the current rate of extinction of species, for 65 million years, the acidity of the oceans, for 300 million years, etc. What we are experiencing is not a simple "environmental crisis", but a man-made geological revolution. Far from constituting an external course, fearless and gigantic, the time of the Earth has become commensurate with the time of human action. In two centuries at most, humanity has altered the dynamics of the earth-system for almost eternity.

Entering the Anthropocene means striving to challenge the political, cultural and ecological models that have shaped it. When archaeologists study history, certain materials stand out so much that they point to an entire period : the Bronze Age, the Iron Age, etc. Although they are far from being exact, these denominations give an idea of what the Men who lived at the time knew how to do. In the Stone Age they controlled fire and made sharp objects, in the Bronze Age they created trade networks to exchange metals for other goods, and in the Iron Age they forged cheaper tools, which enabled them to build more permanent dwellings. In the 1950s, what many scientists call the "great acceleration" happened with the advent of the current consumer society on the now well-known menu of globalization. In 2016, a group of geologists announced that geological data shows that human beings have created so many new materials that have changed landscapes and their environment enough to form a new era, which they called " Anthropocene" .

But beware ! If we include all of humanity in the Anthropocene concept immediately protests will multiply. Indignant voices will rise to say that they do not consider themselves in any way responsible for these actions on a geological scale - and they will be right. The Indian peoples of the heart of the Amazonian forest have nothing to do with the "anthropogenic origin" of climate change; no more than the poor guys in the slums of Bombay, Rio or Casablanca.

"What has tipped the planet into the Anthropocene is above all a vast profit-oriented technostructure, a 'second nature', made up of roads, plantations, railroads, mines, pipelines, drilling, power stations, futures markets, container ships, financial centers and banks and many other things that structure the flows of matter and energy on a global scale according to a structural logic unequal. In short, the change in geological regime is of course the result of the "age of capital". (Jean-Baptiste Fressoz)

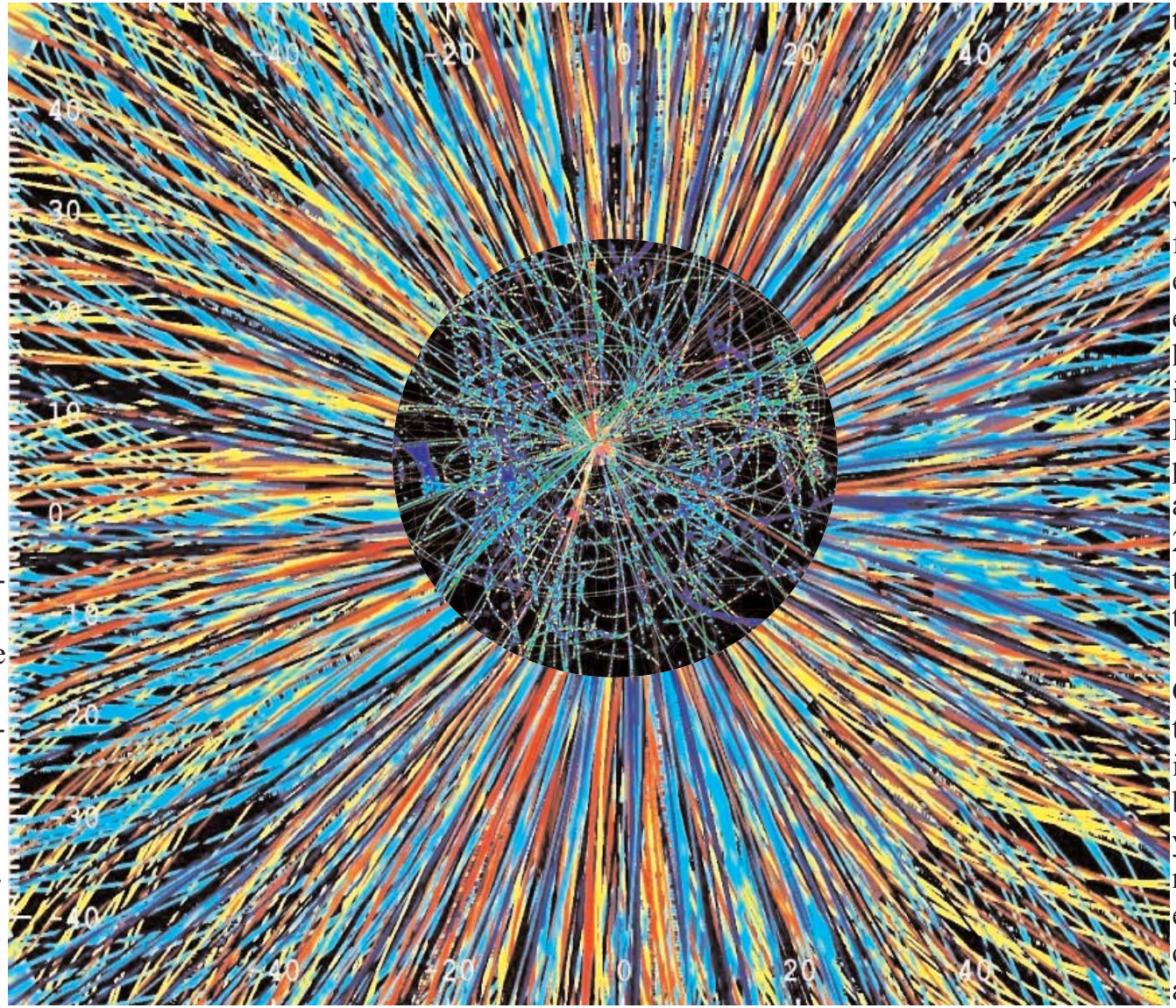
What makes the Anthropocene a clearly detectable landmark well beyond the boundary of stratigraphy is that it is the most relevant philosophical, religious, anthropological and political concept for escaping notions of "Modern" and of "post-modernity". No postmodern philosopher, no anthropologist, no liberal theologian, no political thinker would have dared to place the influence of humans on the same scale as rivers, floods, erosion and biochemistry, even as it became fashion to speak of a "post-human era" when demography is growing exponentially.
Depletion of biodiversity, nitrogen flow, chemical pollution, aerosol load in the atmosphere, overconsumption of fresh water, reduction of the ozone layer, phosphorus flow, soil exploitation, ocean acidification, climate change. So many pitfalls caused by human activities and recognized by many scientific leaders. Of all the materials that surround us, which one could best define the Anthropocene? Here are some ideas for discovering the material whose sudden rise proves the advent of a new era, a new age.
http://www.slate.fr/monde/85913/anthropocene
http://movements.info/sublime-anthropocene/

The Age of Electricity

Scientific discovery and the mastery of electricity have upset our society in the same way as the invention of alphabetic writing during Antiquity and of printing with movable type in the 15th century. Going beyond the technical sphere, electricity, both as a paradigm and as a medium, encompasses knowledge, social practices, media, social life and personal experiences. Electricity has inspired writers and artists, served as a driving force in the world of industry and innovation and has redefined behavior in the workplace, sport and culture. Technologically and economically, what defines our present world…is Electricity. Without it, no chemistry, no petroleum, no internal combustion engine, no plastic, no aluminum, no aerospace rockets, no airplanes, no high-speed trains, no robotics. Without electricity, no electric guitar, no rock&roll , no synthesizer, no hip hop, no hologram , no laser, no silicon chip, no computer, no cell phone, no digital revolution. Without electricity, no nuclear fusion, no nuclear power plant, no atomic bomb. Our industrial, urban and technological civilization as well as the food industry depends entirely on electricity. It is as fundamental as stone, bronze or iron were for our ancestors. It is she who is responsible for the great acceleration of human history and its contemporary corollary: the Anthropocene.

ENERGY - HEAT - ELECTRICITY

Energy is a difficult concept to grasp. First of all, it is a common language word that has many meanings, associated with dynamism, power...



For physicists, it is a physical quantity expressed in joules (J). It is found in many forms: kinetic, potential, mechanical, electrical, chemical, heat, etc. All of these forms have the power to transform into each other. The law that governs these processes is the law of conservation of energy, which states that the total amount of energy remains constant during these transformations.

The energy is therefore never consumed, only converted. The end product of a series of transformations is almost always heat.

The omnipresence of energy
We observe this phenomenon almost everywhere around us. As it bounces, for example, a bouncing ball converts all of its potential energy into heat: its temperature rises slightly, as does that of the ground. The Hi-Fi system draws its energy from an electrical outlet, a significant proportion of which is converted into heat by the amplifier. Even the energy carried by the acoustic waves lands on the walls, where it is absorbed and transformed into heat.

The reverse process - converting heat into another form of energy - is less easy. In a steam engine or engine, only part of the heat is actually converted into mechanical energy. Residual heat is lost. In practice, a heat engine has an efficiency of around 25%. The efficiency of a thermal power plant is of the same order.

Conversion between electrical energy and mechanical energy is possible in both directions with yields close to 100%. The notion of power, expressed in watts (W), corresponds to the speed at which energy is used (or produced), therefore to joules per second.

Hydraulic energy

The production of hydropower began long ago long with the development of water mills. Nowadays, hydroelectricity is produced thanks to vast artificial lakes equipped with gigantic turbines. She rose to the rank of first source of renewable energy in the world... and by far ! The contribution of hydroelectricity to total electricity production worldwide was 16% in 2010, compared to 10% in Europe. The possibilities in Europe are , however, quite small. Hydroelectricity has many advantages. she is good market and does not emit CO2. It allows rapid commissioning and includes its own storage system if the power station is equipped with a dam. It can therefore easily be adjusted according to electricity demand, unlike wind energy and solar. Hydroelectricity, solar energy and wind energy are therefore additional sources of energy.

However, it has drawbacks: the impact on the environment and on the local populations of the construction of dams and power stations, but also the risk of dam failure in case of earthquake.

Wave energy (or tide energy) is nothing but concentrated wind power.

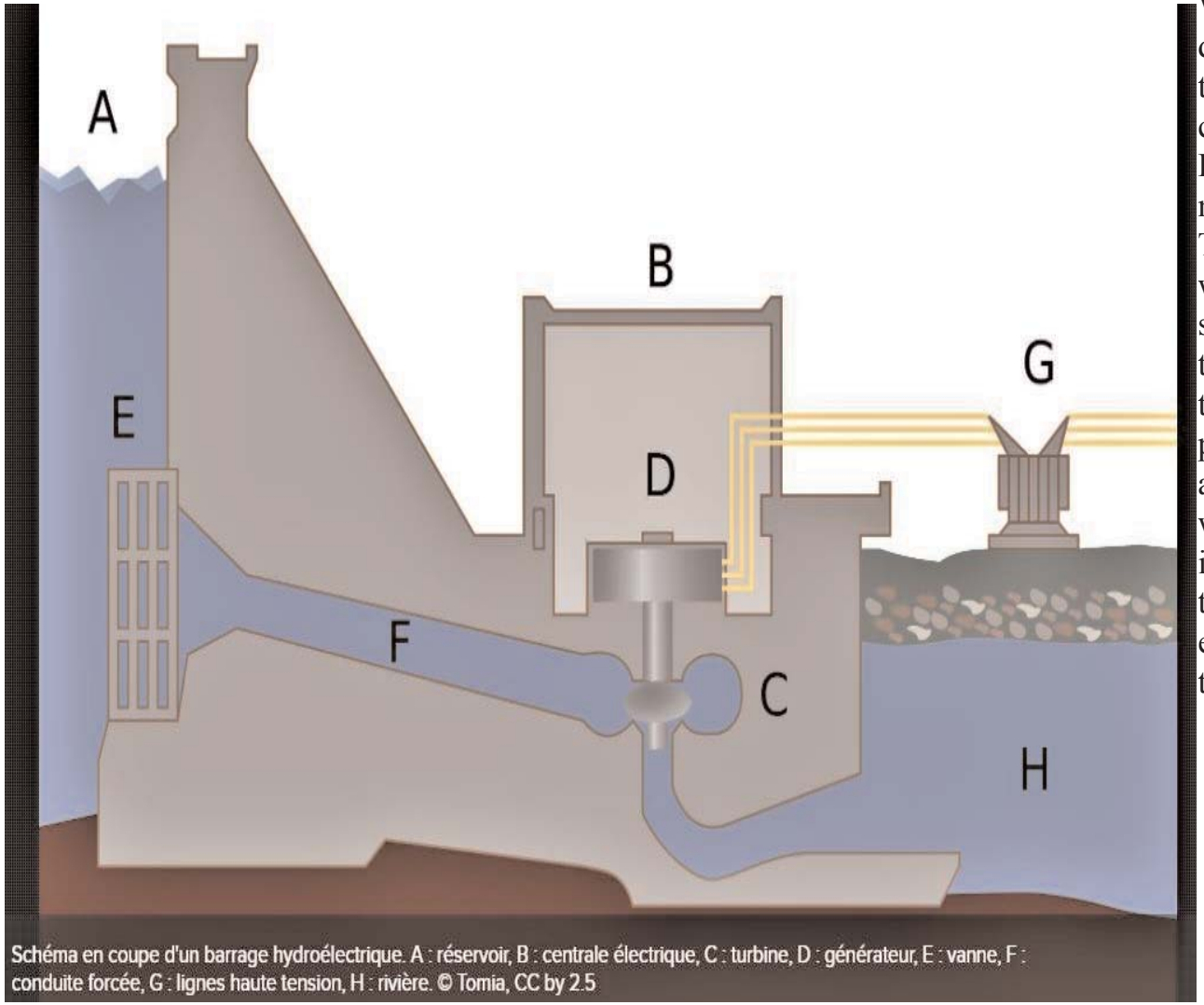


Schéma en coupe d'un barrage hydroélectrique. A : réservoir, B : centrale électrique, C : turbine, D : générateur, E : vanne, F : conduite forcée, G : lignes haute tension, H : rivière. © Tomia, CC by 2.5

With a total potential of 200 GW, it has weaker development prospects than hydraulic energy . As the map says following , the western European coasts are among the best off in the world. Despite many pilot projects implementing technologies varied , it is still in its infancy today. Tidal energy has much more potential weaker than wave energy. She is mostly interesting where the shape of the coast makes it possible to amplify the tidal height differential. We can also take advantage of the thermal energy of seas , using the temperature gradient between marine layers to operate a machine thermal . The osmosis between fresh water and water sea (also known as electrodialysis inverse) could make it possible to produce quantities modest in energy. Technical problems related to semipermeable membrane technology need to be resolved.

GEOTHERMAL

Since the dawn of Humanity, Man has always been able to take advantage of geothermal energy , that energy including geysers, hot springs and eruptions volcanoes manifested their existence to him. The first traces of use of geothermal energy by man date back to nearly 20,000 years . Throughout the history of civilisations, the practice of baths spas has multiplied and, for a century, the exploitations industries have developed for the production of electricity and the heating .

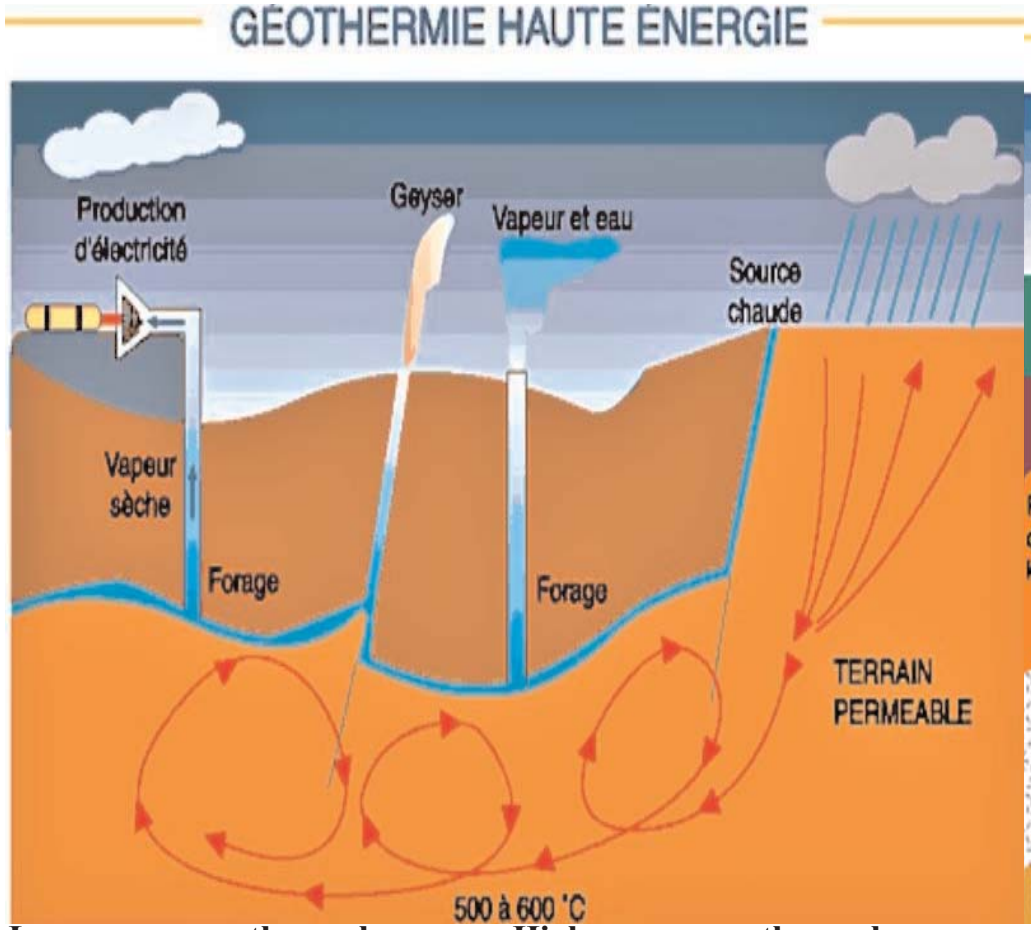
If we have to find distant origins in the use of geothermal energy,
why not ask, like the historians of the Prehistory, what role did hot springs play in the resistance from Humanity to the last glaciations?
The oldest vestiges related to the heat of the Earth, found at the Niisato site in Japan, are stone objects volcanic stones (tools or weapons) dating precisely from the third age , 15 or 20,000 years ago.
Volcanic regions were therefore very early poles of attraction,
to the existence of fumaroles and hot springs that could be used for heating, cooking food or any just bathe.

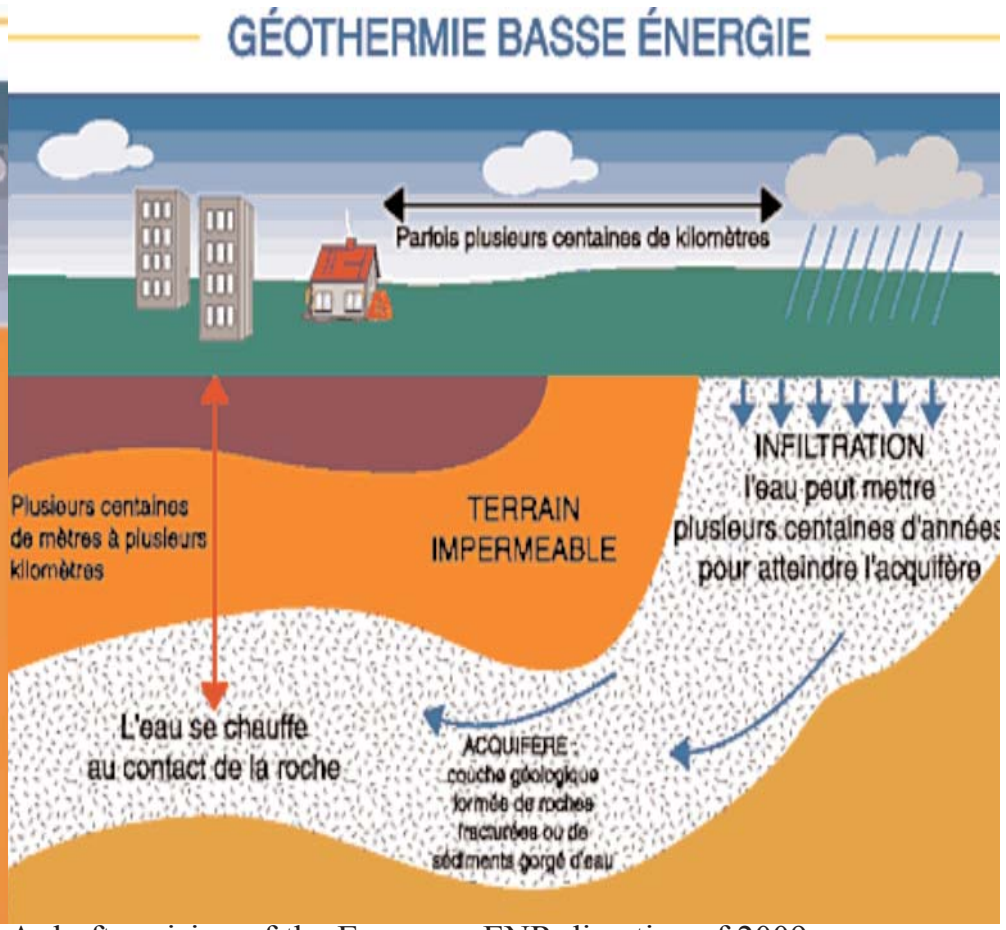
Many archaeological remains bear witness to the practice of baths throughout the history of mankind. Many archaeological remains bear witness to the practice of baths throughout the history of mankind. The thermal baths, place of meeting and exchange

With the appearance of civilization, the practice of thermal baths and the use of thermomineral mud is spreading, both in Japan than in America or Europe.

The Etruscans, then the Romans, made public baths a place of
meeting and exchange of ideas, which they will remain throughout the first millennium of our era, where despite decadence, invasions and feudal harshness , the thermal baths are still highly prized.
The thermal establishments will then multiply in all the regions of the world, and in particular in the volcanic islands of Japan, from Iceland and New Zealand.
However, the discovery of more easily mobilized energies (coal , oil) hardly encouraged its development. To present , geothermal energy is making a comeback.
Today, the situation is changing in terms of energy. exhaustion programmed fossil fuel reserves, the need to preserve the environment and global warming due to the greenhouse effect necessary to make full use of renewable energies. The geothermal energy is one of them.

Earth's heat comes from the decay of elements
radioactive substances present in the rocks and in the earth's core which generate a heat flow to the surface. The greater the depth
greater , the higher the heat, increasing on average by 3°C every 100 meters. But this geothermal gradient can be much higher in certain particular geological configurations.




GÉOTHERMIE BASSE ÉNERGIE
Parfois plusieurs centaines de kilomètres
Plusieurs centaines de mètres à plusieurs kilomètres
TERRAIN IMPERMEABLE
INFILTRATION
l'eau peut mettre plusieurs centaines d'années pour atteindre l'acquifère
L'eau se chauffe au contact de la roche
ACQUIFERE : couche géologique formée de roches fracturées ou de sédiments gorgé d'eau

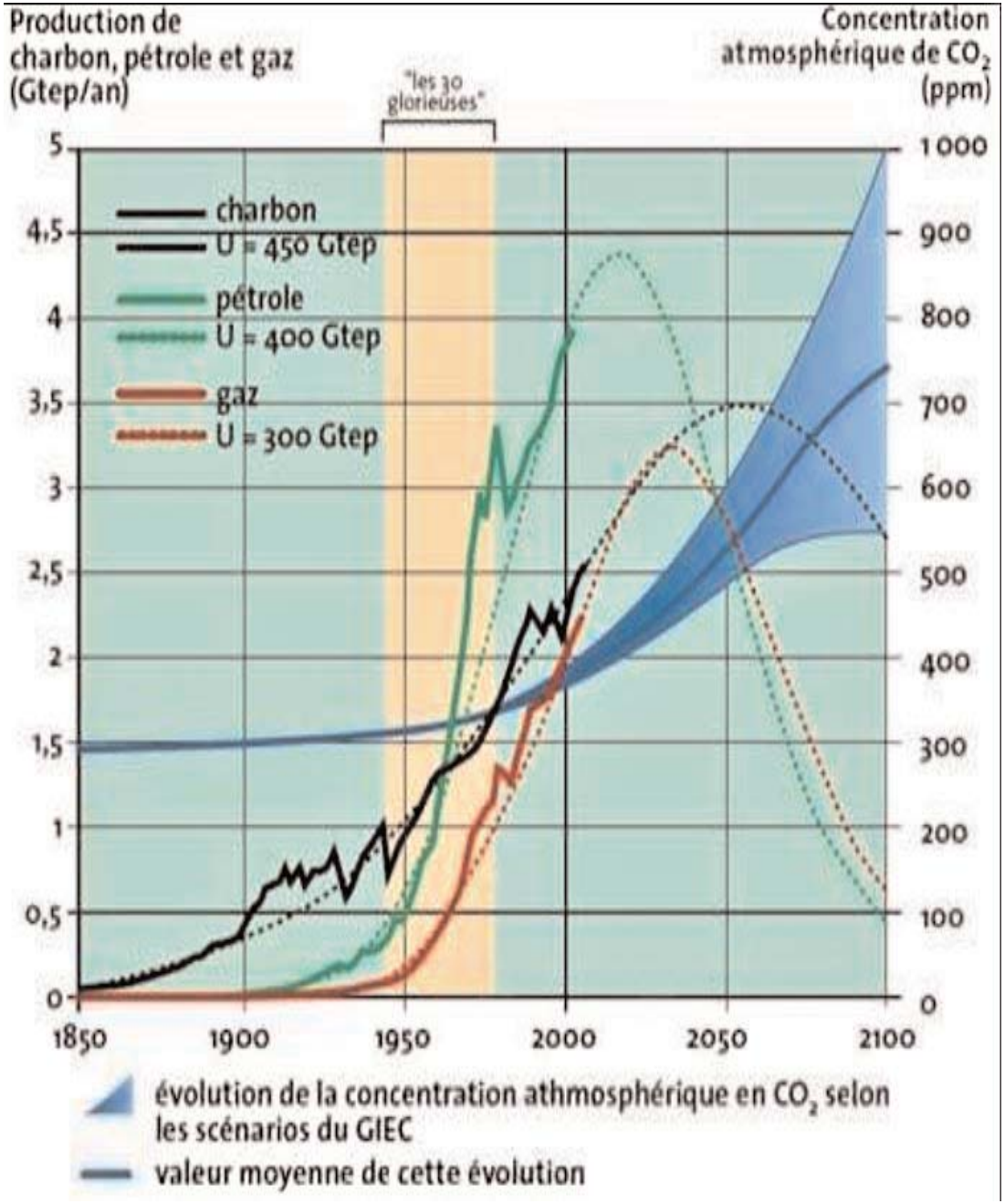
Low energy geothermal energy - High energy geothermal energy

Certain underground geological formations naturally contain aquifers whose waters (and/or steam depending on the conditions of temperature and pressure) are the carrier of thermal energy.
Very low energy geothermal energy uses reservoirs located at less than 100 meters and whose waters have a lower temperature at 30°C. It is used for heating and/or air conditioning, via a heat pump . Low-energy geothermal energy relies on aquifers at temperatures between 30 and 100°C. It is used in heating networks for district heating or in the context of industrial processes, for example. geothermal energy medium energy and high energy (up to 250°C) is used for generate electricity using turbines.

A draft revision of the European ENR directive of 2009 provides that at least 27% of the electricity production of the EU will come from renewable energies by 2030... Regarding more specifically geothermal energy, France's objectives are to produce 850 ktoe (kilotonne oil equivalent) in very geothermal low energy, 500 ktoe in low and medium energy geothermal energy and 80 MW in high-energy geothermal energy. Because geothermal energy is the only source of renewable energy which is aimed at the two major sectors energy : production of electricity and production of heat. It is regular, with an average availability of 80%, and not polluting . And it has reached a level of technical and commercial maturity which allows him to compete without complex with the others renewable energies.

However, the resources are considerable and, in certain points of the world (volcanic islands in particular), easily mobilized. As for the costs of energy production (in the case of electricity, higher than with fossil fuels - with some exceptions, a strong development of geothermal energy, pledge of acquired scientific and technical, would make it possible to reduce them, while limiting the risks incurred by investors.

We are not yet out of the age of fossil fuels. If the coal has lost ground since the Glorious Thirties, in particular in Europe, oil and gas are still living their golden age. Since the start of the industrial era, there has been a growth regular consumption of fossil fuels - at the very origin of the exceptional "development" that our generation and that of our parents - to the point of risking exhaustion of them (oil, gas). At the end of 2015, the reserves of oil (gas) in the world corresponded to some 51 years (53 years) of world production, at the rate of current consumption. The so-called theory of peak oil " wanted that between 2010 and 2040, we pass the peak beyond which production would fall inexorably (black, green and red curves). But again, the new productions have come to challenge this theory . At the same time, the carbon dioxide emitted by the combustion of these fossil fuels leads to an increase gas levels in the atmosphere. Depending on the efforts that will be made by producers and consumers to reduce the growth rate of these emissions, we will be able to stabilize these emissions on the horizon 2040 (blue curve). These efforts are all the more necessary that the increase in greenhouse gas levels induces an increase in the average temperatures of the atmosphere, source of various disturbances and in particular of events weather . What is the future of geothermal energy in the face of fossil fuels?
Brent prices remain favorable despite several shocks tankers and the sporadic increases that accompany Middle East crises . They therefore retain the favor of consumers, all the more so as the distribution circuitsare consolidated and extended, particularly for gas. Will we have to wait for the scarcity of resources to react and turn to renewable energies? It would not be a particularly innovative spirit of anticipation! Because it would only be a question of anticipating by a few years the exhaustion inevitable resources.



Geothermal energy uses the heat flow from the center of the Earth. Almost everywhere on Earth, the temperature is around 30°C above higher at a depth of one kilometer than at the surface. geothermal energy has enormous potential. She is not, however, really renewable , since it uses stored geothermal heat in depth over time. The regions (mainly volcanic) that harbor high-temperature reservoirs or formations can be taken advantage of to generate electricity. But most parts of the world can exploit geothermal sources for heating, using heat pumps if necessary. drilling technology can be inspired by those of the oil industry.

Solar energy
The Sun is our energy source par excellence. It is him who provides the energy that makes life on Earth possible. We owe him also a very useful legacy in the form of oil reserves, gas and coal.

It would be enough to capture a tiny fraction of the sun's energy to supply energy to all of humanity. In the absence of clouds , when the sun is high in the sky, every square meter receives 1 kW, the equivalent of a standard electric heater. For many applications, it is the flow of solar energy net average that matters. It takes into account the influence of clouds and of the night and varies greatly with the seasons.

The best way to use solar energy is also the simplest : direct use of the heat of the sun. A window holds almost 80% of the incident heat flux. The principle of sensors solar panels is simple: a black plate at temperature room absorbs almost all solar radiation. If we uses to heat water, they can take advantage of solar flux intense during the summer months. For heating, it is necessary to combine them long - term storage. This is possible in the case of large housing units, such as a housing estate or building of offices. A back-up unit is required, powered for example by gas .

Photovoltaic cells, light energy
Photovoltaic cells convert radiation directly incident solar power. Cell performance on silicon) reaches 25% in the laboratory and 14 to 20 % for business models. To improve performance, we can combine different materials including color sensitivity is different: the light transmitted by a layer can be absorbed by the next. These are called multijunction cells . A yield of 44.7% was achieved in 2013 by a team of research including the CEA, with a new four junction solar cell structure . Many others developments are underway.

Solar cells are much more efficient than photosynthesis, but large areas are still necessary for production substantial amount of electricity. To produce the equivalent of a power plant conventional (1,000 MW), France would need a net area of 53 km2 of solar cells with an (optimistic) yield of 15 %!

Wind energy is nothing but solar energy in disguise. It's sunshine heating the earth's surface, which gives rise in the wind. Immediate consequence: the global potential of energy wind power is much less than that of solar power.

Nevertheless, the potential of wind energy is far from negligible. A large number of wind turbines installed in a windy place can compete with a power plant, provided that the wind turbines are sufficiently spaced. By optimizing the layout of a wind farm, we reach total powers of 1 to 3 MW/km2. This is much lower than the area efficiency of the cells photovoltaic , but slightly higher than that of plants by photosynthesis . Without forgetting that wind energy is an energy mechanical and can therefore be converted into electrical energy with very little loss. It takes about 1,000 large wind turbines of 3 MW of nominal power, with a rotor of 80 to 90 meters in diameter , to replace a conventional plant of 1,000 continuous MW.

The usefulness of air masses for renewable energy
The deployment of wind energy varies greatly from country to country. In 2012, for example, the installed capacity cumulative total

was 31.3 GW in Germany, 22.8 GW in Spain, 8.4 GW in the United Kingdom and 7.6 GW in France, for a total of 106 GW against 75 GW in 2009. It should be remembered that these figures correspond to the nominal power. The power delivered , on an annual average, is about three to five times lower and depends, among other things, on the wind conditions during the year . In 2012, the European Union produced 6% of its electricity thanks to the wind.

Fluctuations in wind power require the use of rapid-response back-up electric generators to compensate for a drop in production. Part of fossil fuel savings and CO2 emissions promised by wind turbines are cancelled . Wind power has other disadvantages, such as noise and its adverse effects on wildlife.

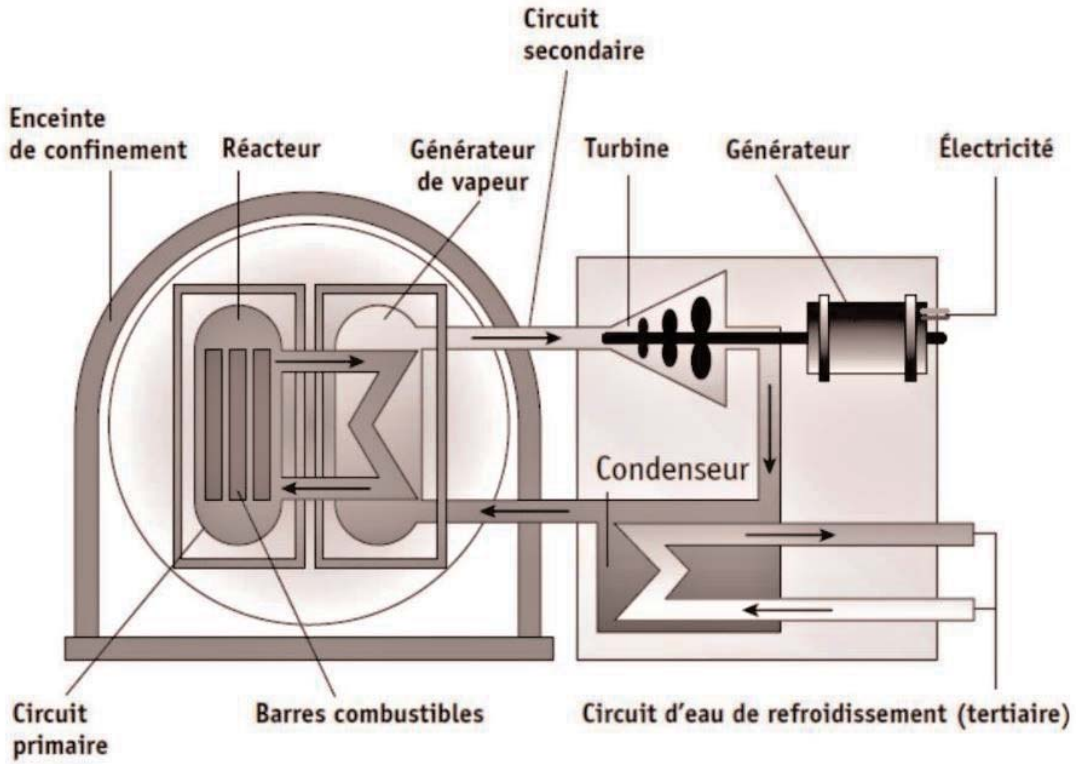
Energy from nuclear fission

The nuclear technology currently used everywhere on Earth is based on fission. It uses the most massive cores, including nucleons are slightly "too heavy" compared to those of atoms of intermediate mass. The difference is very small (less of 1% per nucleon) but it corresponds to a gigantic energy, that we seek to exploit. The 435 nuclear reactors in service in the world in 2014 use this principle to generate electricity.

Specifically, they do not directly produce electricity but heat. This heat is then used to drive a steam turbine which in turn powers a large generator . The specificity of nuclear therefore lies in the first step : generate heat from nuclear reactions. Nuclear energy provides 13% of the world's electricity production (2011 data), i.e. approximately 5% of total consumption of energy . In France, it provides 76% of electricity production. In its current form, nuclear energy is based on the fission of uranium , specifically its rarest isotope (uranium 235).

Current uranium reserves would supply the fuel sector for about 100 years, at the level of price and of current technology. This duration would be significantly extended if we took into account the more expensive uranium reserves. If we mined the most abundant uranium isotope (uranium 238), the possible duration of exploitation would increase by at least one factor 100. However, this is only possible with breeder reactors which are capable of converting uranium 238 into plutonium.

Centrals nuclear power are mainly adapted to provide the " load " of electricity, not to respond to fluctuations quick on demand. The advantages of nuclear fission are to decrease the dependence to gas and oil producing countries, to be interesting economically and not to emit CO2. The fission has the downside of allowing misuse of energy nuclear (proliferation). Uranium 235 and plutonium 239 (which is produced automatically in small quantities when a reactor works) can be used to make a nuclear bomb. That said, this requires producing significantly more uranium enriched than that found in a reactor, or to extract the plutonium 239 from spent nuclear fuel.



Although modern nuclear reactors obey all criteria , major accidents can occur in the event of a cooling system failure. It is mainly of the residual heat that is produced even after the shutdown of the reactor, as the disaster showed of Fukushima in 2011. Intrinsically safe reactors are under development, but they will not be available before 2020.

The treatment of nuclear waste remains a problem to be solved, even if the quantities of waste remain small: they can be stored without danger in salt, clay or granite mines. The disadvantages of nuclear energy must be carefully weighed against the effect of fossil fuels on climate change.

Nuclear fusion: what advantages?

Nuclear fusion will not be able to contribute to the world's energy production before 2050. It is still in the experimental phase. But if its technical and economic feasibility is demonstrated, its potential is enormous since it uses a fuel available for billions of years. One liter of ordinary water contains enough deuterium to produce the energy equivalent of 200 liters of oil. Fusion reactor fuel is plentiful and available. Fusion reactors will undoubtedly take the form of large installations, comparable to current fission reactors producing 1,500 MW of electricity. Problems related to waste treatment will probably be much less for fusion reactors than for current fission reactors. Major accidents seem unlikely with the merger.

Energy storage and transport at the heart of current issues

Storing energy is essential to respond to fluctuations in energy production and demand. The demand for electricity, for example, can change very quickly. If we want production to be able to respond to this permanently, we must have a large installed capacity in terms of power stations.

The capacity of the network must be able to cope with any peak in electricity consumption, even if it only occurs once a year. All of this is expensive, since this overcapacity remains underutilized for the rest of the year. It would be more economical to store electricity to meet these peaks.

Energy storage and transport at the heart of current challenges

photosynthesis and nature
Nature has developed an efficient system, which includes storage: photosynthesis. Would this be a viable energy supply solution? To meet France's current energy consumption by growing plants in a renewable way, the whole country would have to be cultivated! We should therefore not expect too much from biofuels. The problem with photosynthesis is its low yield: only a small part of the flow of solar energy is exploited (less than 1% in our countries).

It is also necessary to be able to move energy in space. In our car, energy is stored as gasoline or diesel, plus a small amount in the battery. With the development of solar or wind energy, the transport of energy will become an important issue.

Storing heat in water is relatively efficient and easy for short-term storage (a few days). The solar water heater is a good example. On the other hand, using water for long-term energy storage (eg six months for heating) is only possible with large installations. New developments such as thermochemical heat storage can reduce the volumes required, especially for long-term uses.

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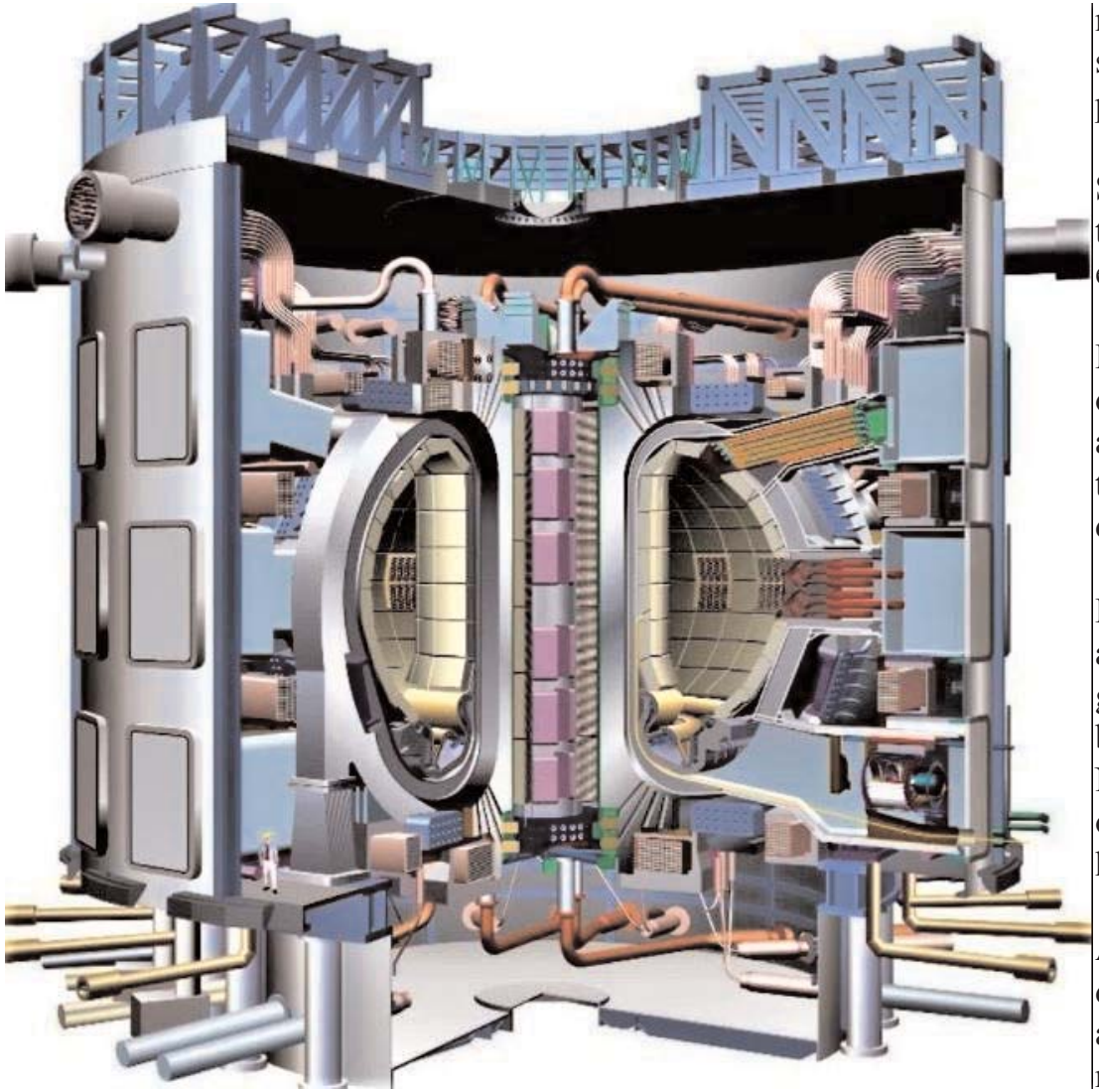


the other hand, using water for long-term energy storage (eg six months for heating) is only possible with large installations. New developments such as thermochemical heat storage can reduce the volumes required, especially for long-term uses.

Large-scale electricity storage is more efficient in the form of mechanical energy, with reservoirs or high altitude lakes for example.
Small-scale electricity storage (for electric vehicles or laptop computers, for example) can be done using modern batteries, such as metal-metal hydride batteries or lithium batteries. Although superior to lead batteries, they remain heavy and bulky compared to fossil fuels, which limits their mobile applications.

Supercapacitors make it possible to quickly store and use electrical energy, since they can operate at high power. The recovery and reuse of braking energy are applications.

Hydrogen used as an energy carrier has a bright future ahead of it, particularly for transport. It can be produced from water and electrical energy. Subsequently, this hydrogen can be used to produce electricity directly using fuel cells. The direct production of hydrogen from solar energy is under study.

Hydrogen comes up against the problem of storage for mobile applications. The simplest solution is to use hydrogen in gaseous form at high pressure. Hydrogen filling stations are being built along highways in several countries (USA, Norway, etc.). Nevertheless, for an ordinary vehicle, gasoline or diesel remain much more practical. All other solutions are heavier, bulkier and bulkier.

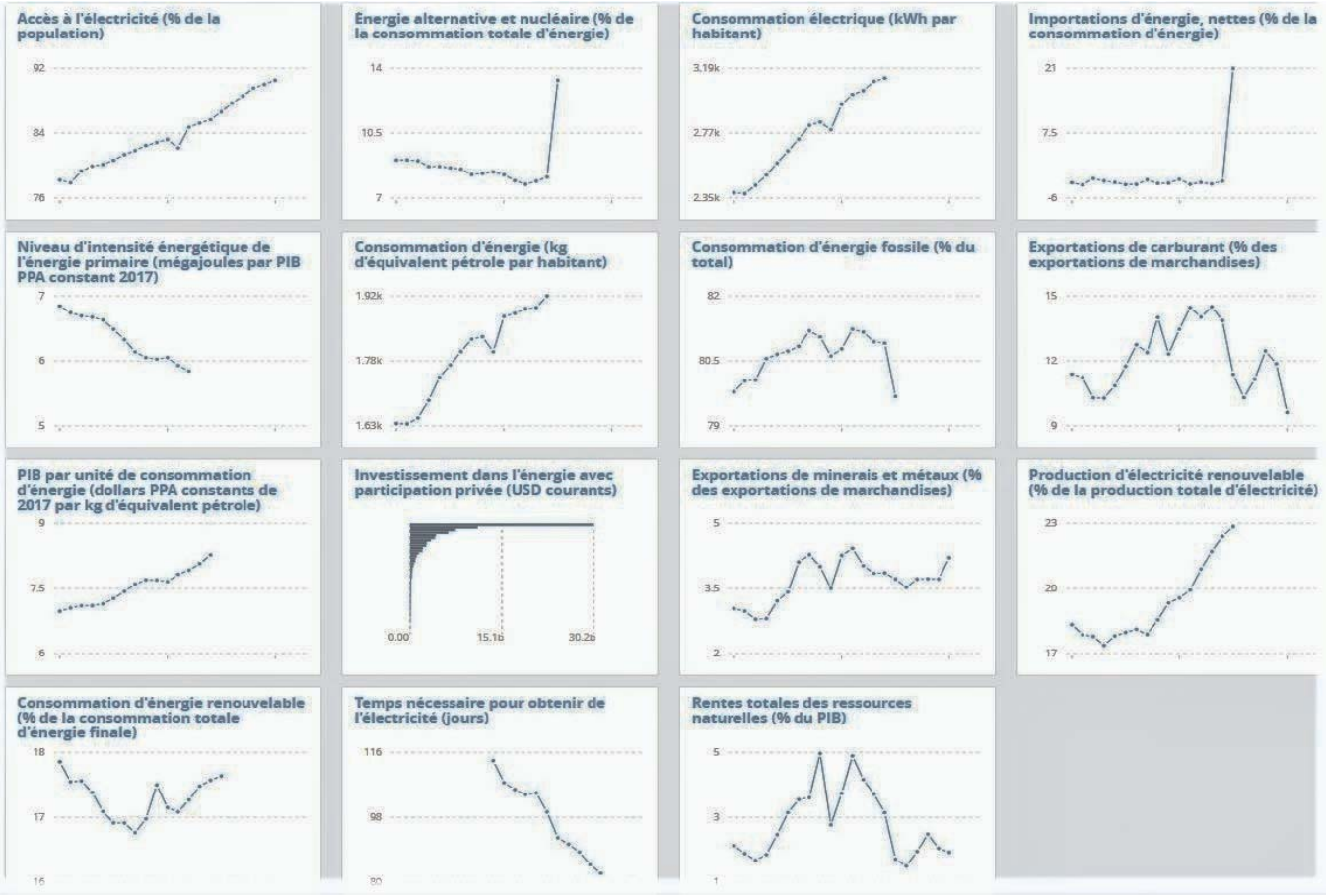
Access to modern forms of energy improves many aspects of daily life. Improved sanitation systems, well-functioning health and education services, and efficient transport and telecommunications all depend on a reliable supply of electricity. With just one light on in a room, a child can read or do homework in the evening, while the continuous power supply keeps larger appliances running, food cold and businesses flourishing.

Expanding access to electricity and other forms of energy is fundamental to improving the lives of individuals and communities. The proportion of people around the world with access to electricity and clean fuels has increased significantly over the past decade. In 2018, 90% of the world's population had electricity, up from 82% in 2008. Access to clean fuels and cooking techniques increased from 55% to

63% over the same period. Yet, despite this progress and due to strong population growth in regions of the world poorly equipped with energy infrastructure, nearly 789 million people still did not have access to electricity in 2018. An even greater number - 2.8 billion - does not have clean fuels and cooking techniques.

Increasingly, people without access to electricity are concentrated in sub-Saharan Africa. In this region, although the electricity access rate increased from 34% in 2010 to 47% in 2018, hundreds of millions of people are still in the dark.

The 20 countries with the largest access deficits - 14 of which are in sub-Saharan Africa - were home to 78% of the world's people without electricity in 2018.

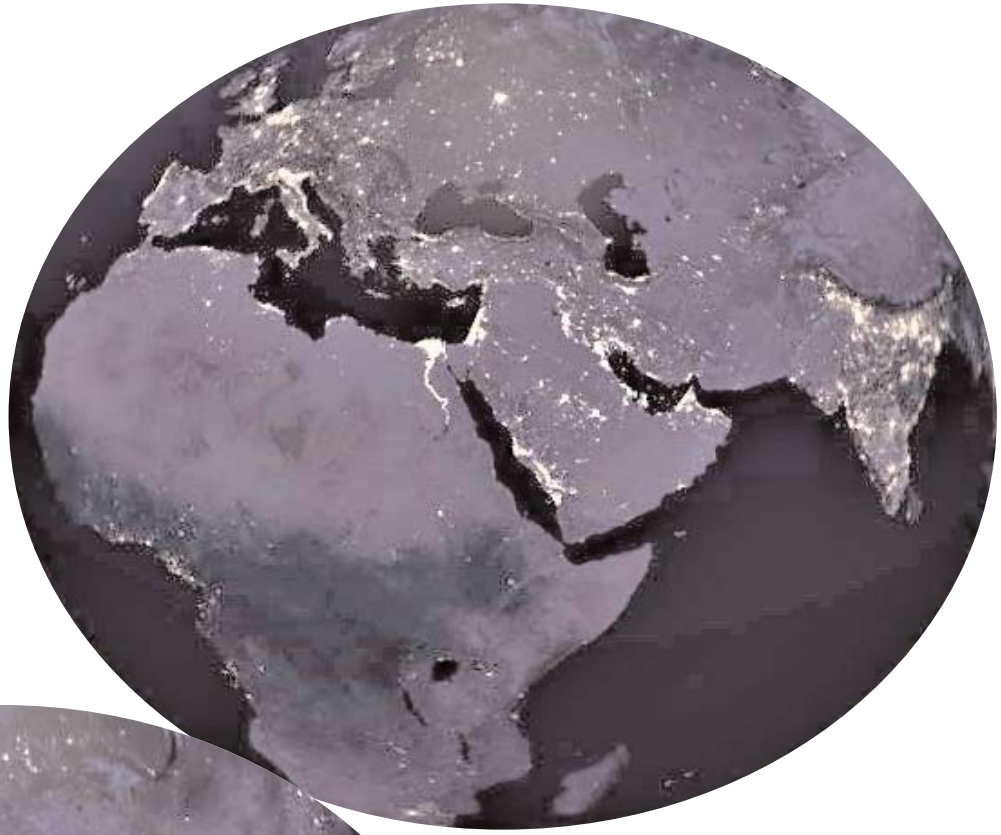

Accès à l'électricité (% de la population)
Énergie alternative et nucléaire (% de la consommation totale d'énergie)
Consommation électrique (kWh par habitant)
Importations d'énergie, nettes (% de la consommation d'énergie)
Niveau d'intensité énergétique de l'énergie primaire (mégajoules par PIB PPA constant 2017)
Consommation d'énergie (kg d'équivalent pétrole par habitant)
Consommation d'énergie fossile (% du total)
Exportations de carburant (% des exportations de marchandises)
PIB par unité de consommation d'énergie (dollars PPA constants de 2017 par kg d'équivalent pétrole)
Investissement dans l'énergie avec participation privée (USD courants)
Exportations de minerais et métaux (% des exportations de marchandises)
Production d'électricité renouvelable (% de la production totale d'électricité)
Consommation d'énergie renouvelable (% de la consommation totale d'énergie finale)
Temps nécessaire pour obtenir de l'électricité (jours)
Rentes totales des ressources naturelles (% du PIB)

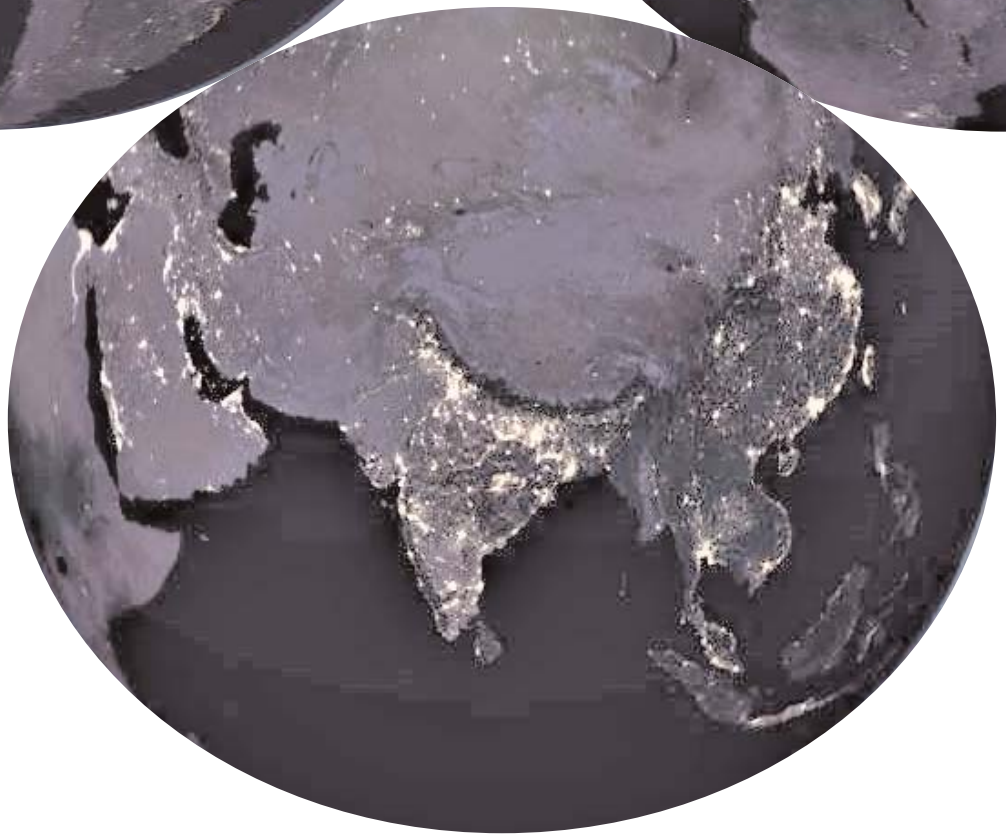
The access deficit is also disproportionate in rural areas. While access to electricity is almost universal in cities globally (97%), the situation is very different in the countryside, where only around 80% of inhabitants are connected to the electricity grid. Rural dwellers make up the vast majority (85%) of the world's population without electricity.

The urban-rural gap, if it persists, has nonetheless narrowed somewhat over the past ten years. Access in rural areas has increased by more than one percentage point per year, while in urban areas the increase has plateaued at 0.1 percentage point per year.

Today, access to electricity does not necessarily mean connection to a central electricity grid, which is often difficult in rural areas. Thanks to dramatic advances in technology, such as solar home systems and mini-grids based on renewable energy, off-grid electricity has become an increasingly efficient and affordable solution.

The importance of electricity beyond homes
Electrification brings benefits in homes, but also beyond, such as in hospitals and schools. Modern medicine is particularly dependent on electricity, and preferably on a reliable and constant supply. In hospitals, electricity allows the operation of equipment that keeps patients alive, for example the mechanical ventilators used to relieve patients suffering from severe forms of COVID-19. But it is also necessary for everyday uses, such as supplying refrigerators in local health centres. Many vaccines are temperature-sensitive and risk being ineffective if their refrigeration is disrupted by power outages.





Here is a nighttime view of Earth that shows the sources of artificial light. It was created from different satellite images taken by NASA and the United States Agency for Oceanic and Atmospheric Observation during the year 2016. This type of visualization can be used to better understand the levels of access to the electricity in the world.

And while there's no perfect correlation between nighttime lights and access to electricity, this image highlights stark inequalities between different parts of the world. In some cases, electricity is so abundant that it seems almost purposely wasted, the light even reflecting in space. By contrast, in other places, tens of millions of people are plunged into darkness at night and go undetected by the satellite.

A 2018 survey of 730 health centers in six low- and lower-middle-income countries found that about a quarter of them lacked electricity. And another quarter reported untimely outages that compromised their ability to provide care.

Schools also benefit from access to electricity. Lighting, fans and air conditioning systems help maintain a comfortable and productive learning environment. Computers and printers, which are essential tools in many classrooms, do not work without power.

In the same six countries, only 40% of schools had electricity, and less than half had 24-hour power. In almost a third of schools, equipment had been damaged due to voltage variations.

Energy, beyond electricity

Energy is not limited to electricity. Energy is used directly from fuels for cooking, heating, transport and industrial processes.

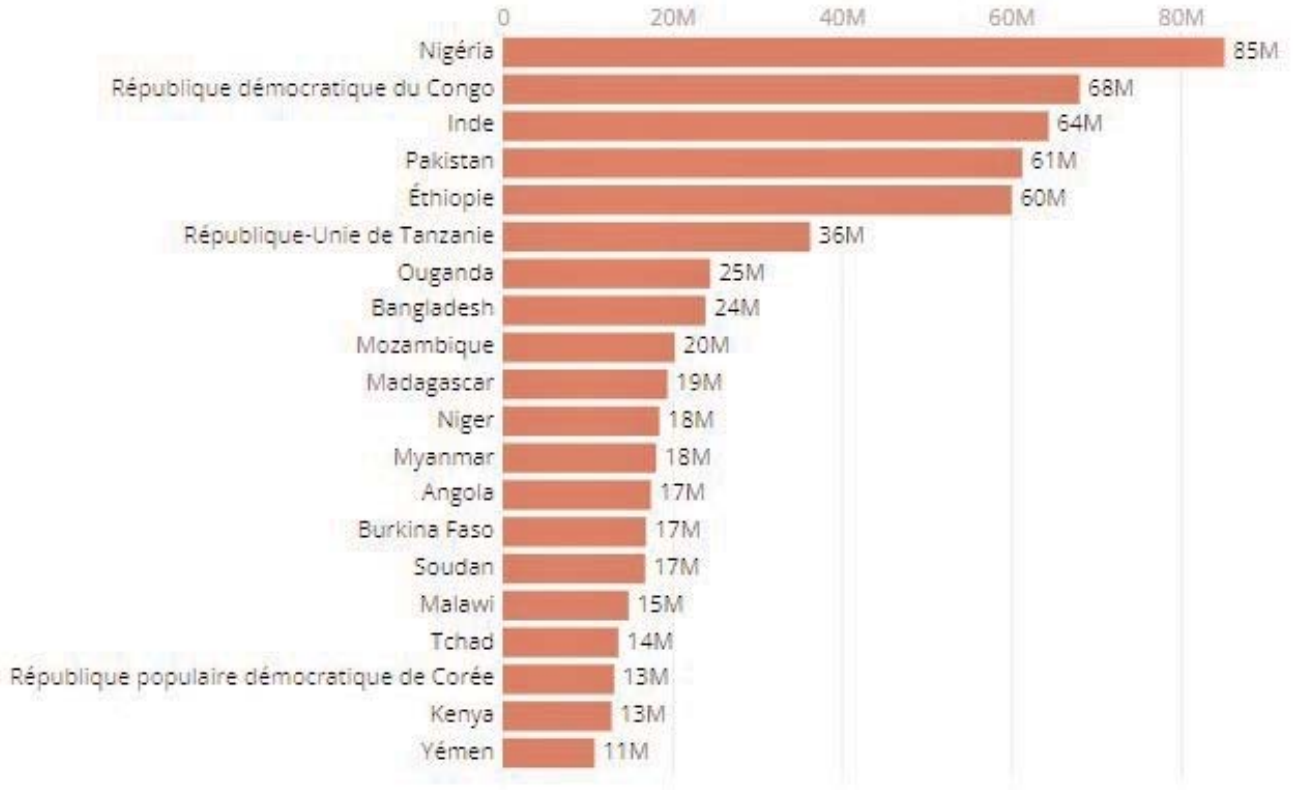
Around 2.8 billion people around the world cook using traditional fuels such as wood, charcoal and animal waste. Their combustion pollutes the air in homes, which can cause respiratory diseases and other pathologies. According to the World Health Organization, nearly 4 million people die prematurely from illnesses attributable to this pollution.

The Development Goals target is to ensure that these households switch to clean fuels and cooking techniques, such as electricity, liquefied petroleum gas, natural gas, biogas, solar energy and alcohol-based fuels. However, access to these techniques remains lower than that of electricity.

The energy transition can be remarkably rapid, given the right policies and economic circumstances.

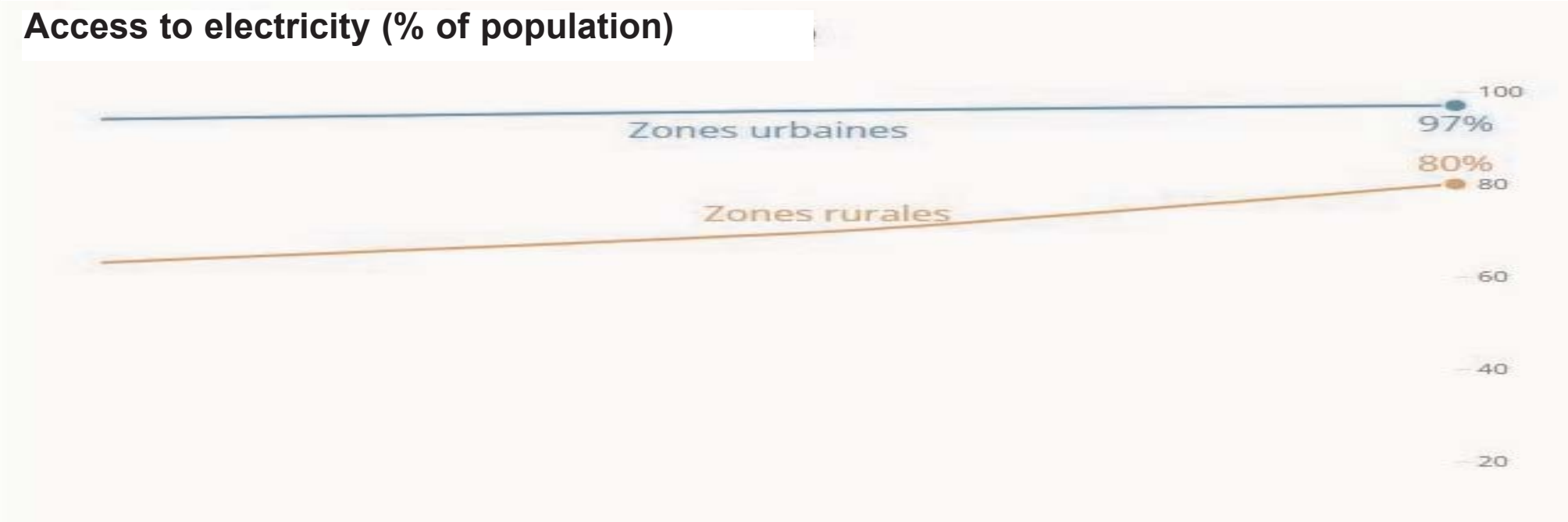
For example, for decades, kerosene has been a popular cooking fuel in Indonesia, thanks in part to government subsidies. In 2007, rising oil prices prompted the launch of a national program to replace kerosene with petroleum gas.

The 20 countries in the world with the highest number of inhabitants without electricity (2018)

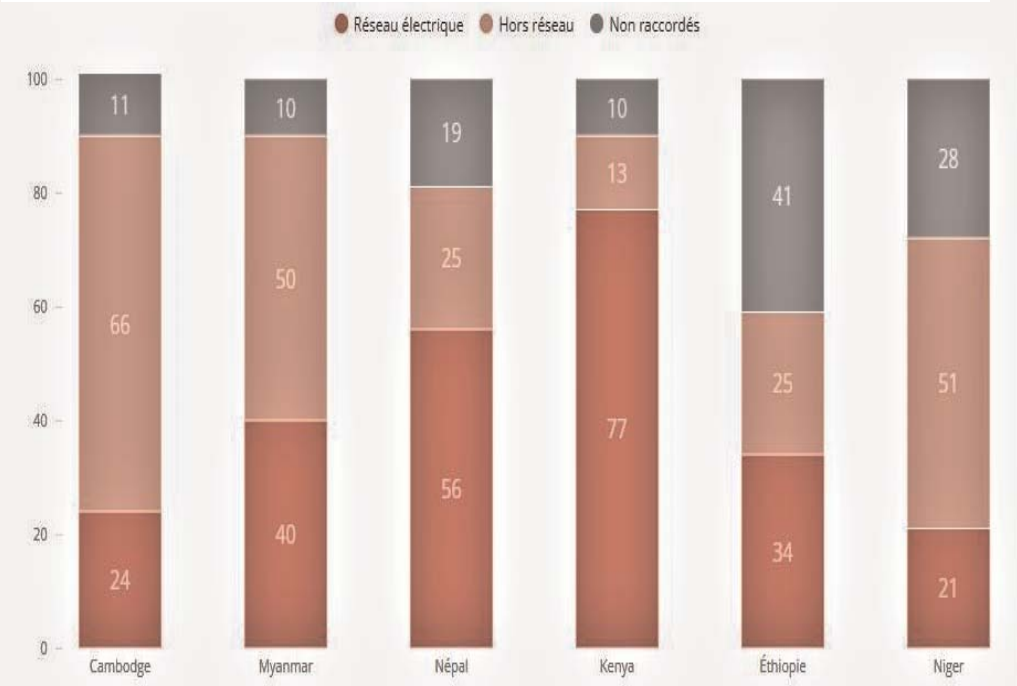


Rural electrification efforts have narrowed the gap between town and country

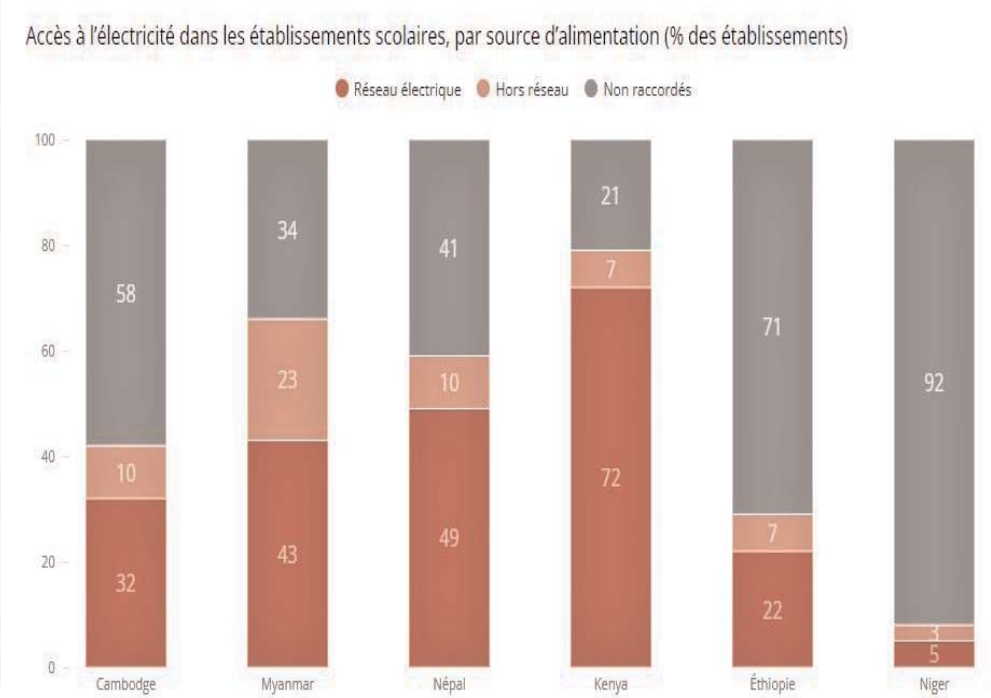
Access to electricity (% of population)



Access to electricity for healthy years (% of establishments)

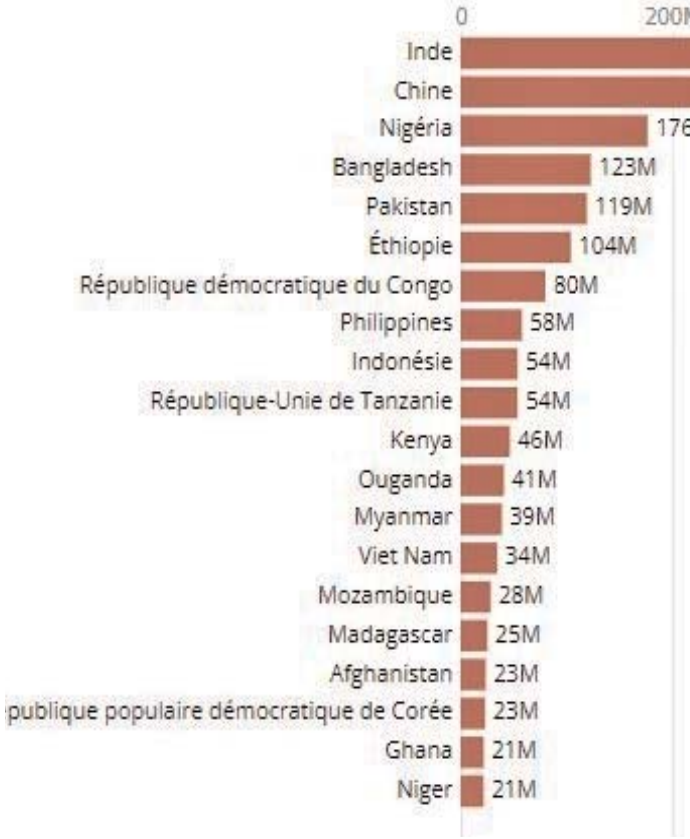


Access to electricity in schools (% of schools)



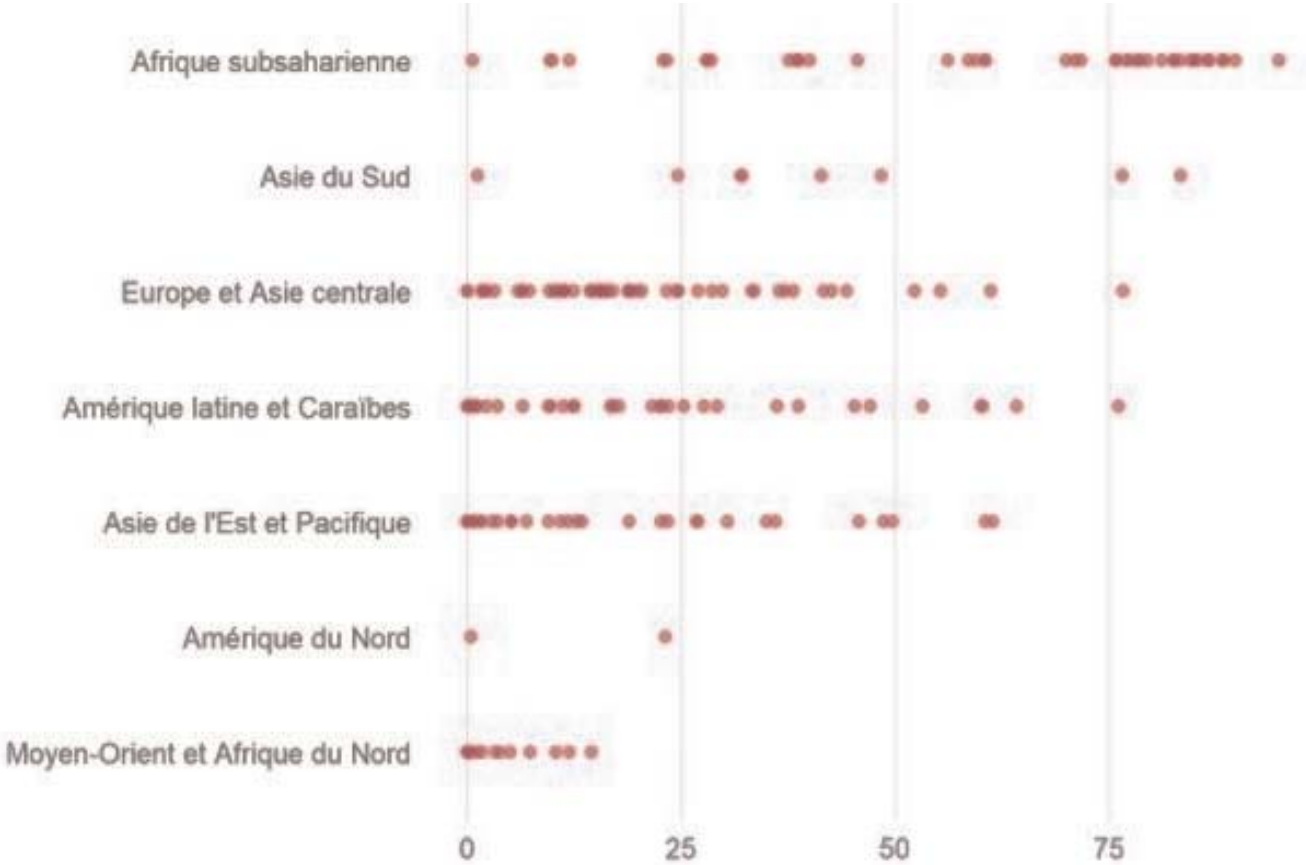
About 2.8 billion people use traditional cooking and fuel methods with health risks

The 20 countries in the world with the largest number of inhabitants without access to clean cooking methods (2018)



Renewable energy levels in sub-Saharan Africa stem from traditional use of biomass

Share of renewable energy in total final consumption (2017)



Amount of energy needed to produce 1 dollar in goods and services

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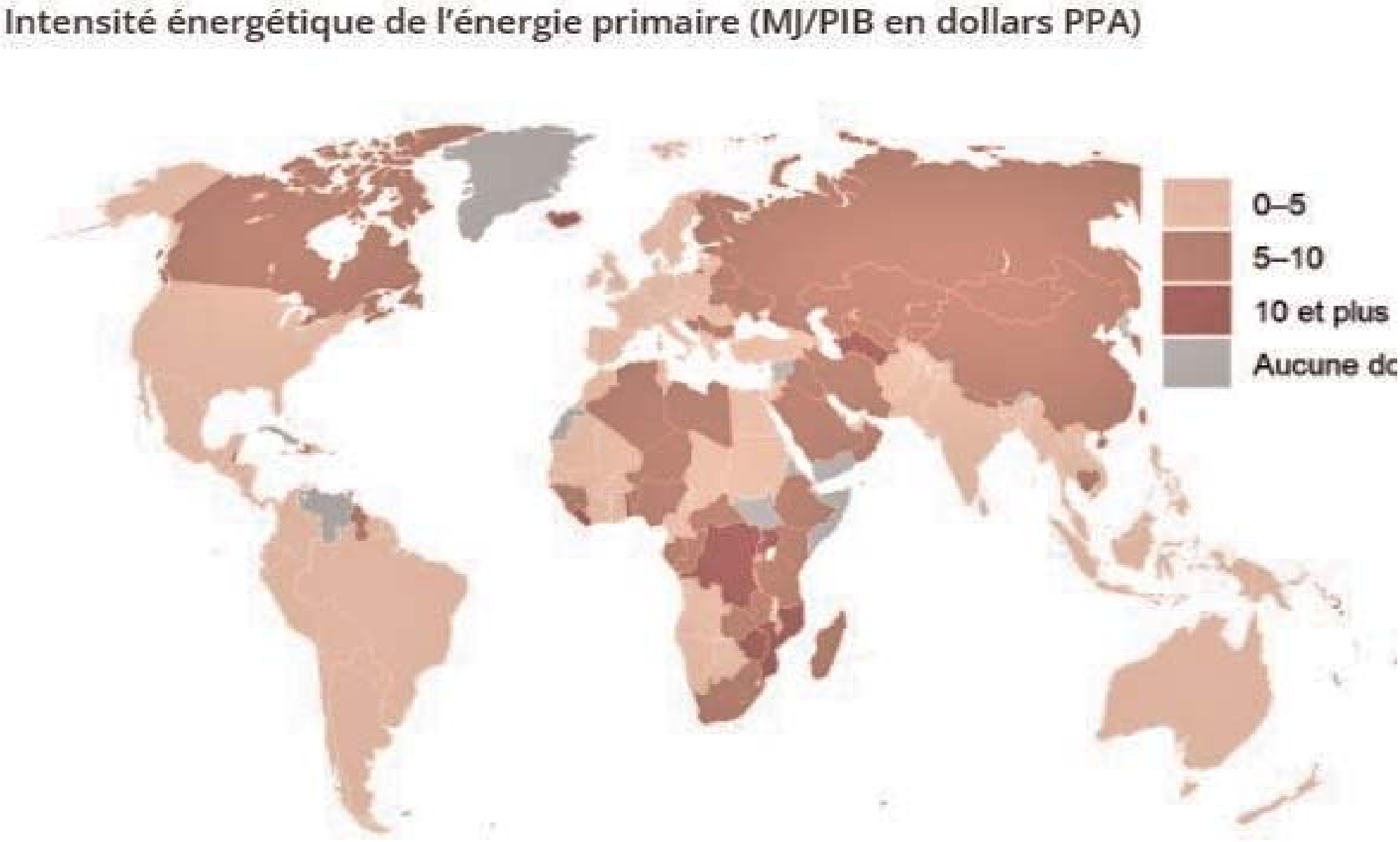
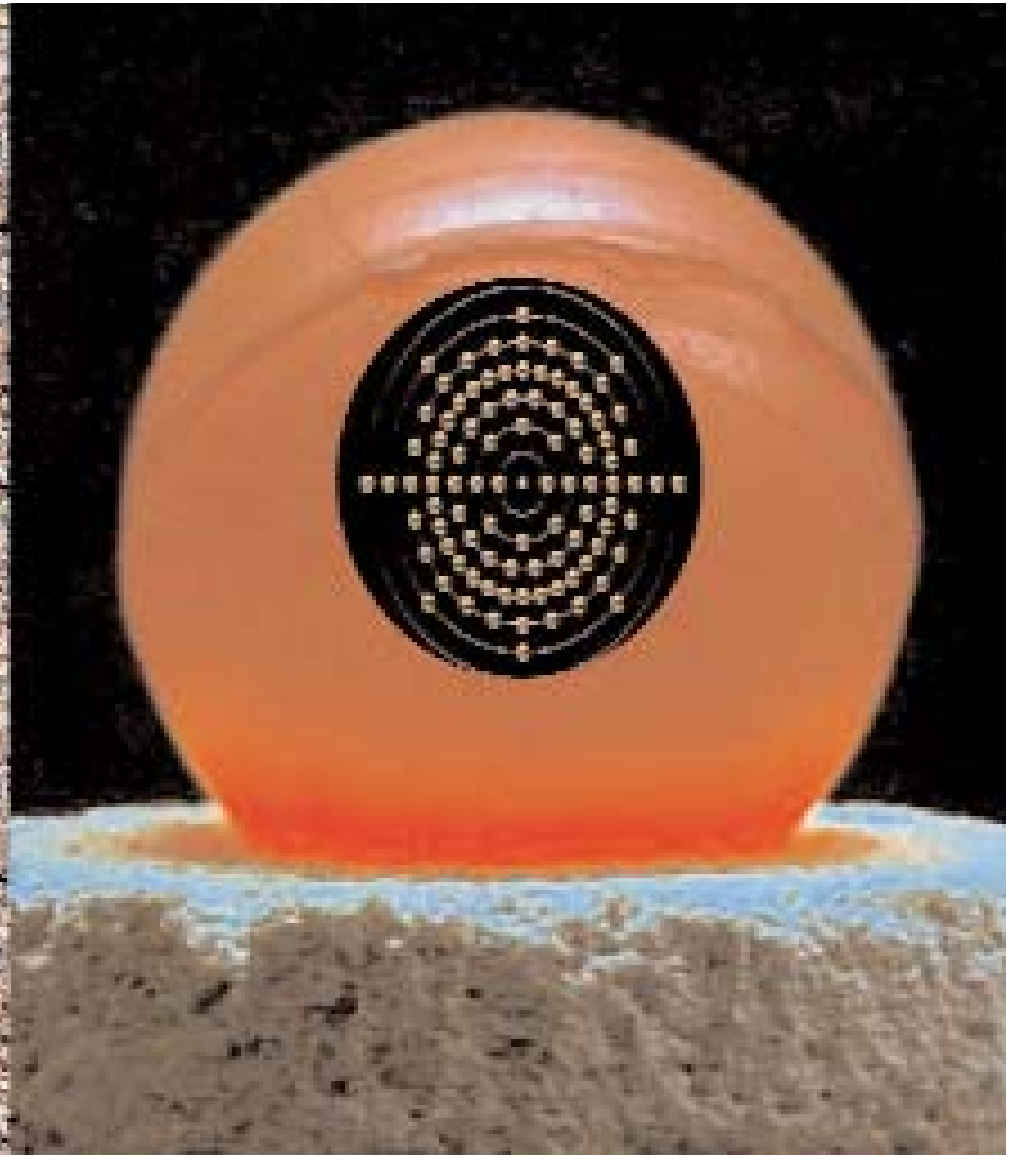


The age of aluminum

Pure aluminum was once so rare that it was more valuable than gold. After the development of the production of aluminum by electrolysis, a discovery thanks to electricity which allowed its refinement, this shiny metal set out to conquer the world. Rigid and light, aluminum offers the advantage of being very little subject to corrosion, plus a unique combination that makes it indispensable in various construction industries. In addition to its use in the manufacture of cans and sheets, aluminum has become indispensable for aerospace technology and, therefore, for civil aviation, trains and automobiles.

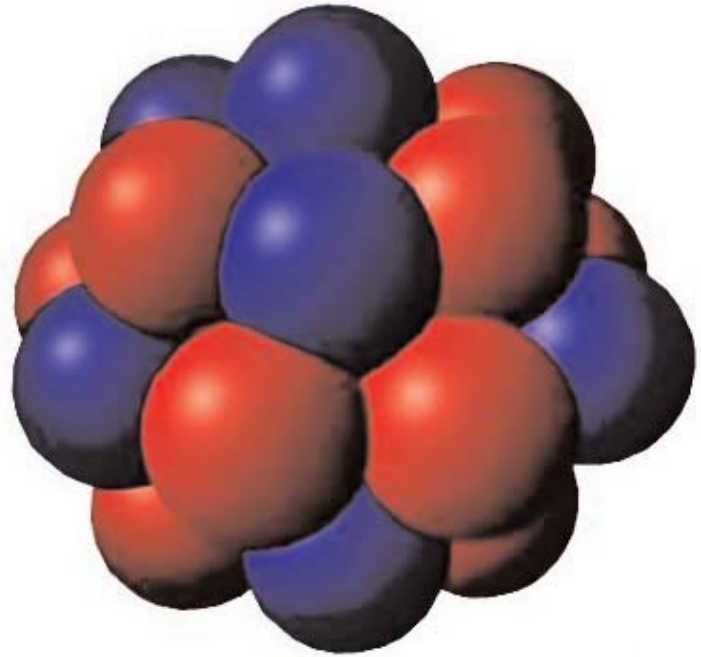
The age of plutonium

Without the nuclear energy of the sun, there is no life on earth. Plutonium was discovered around 1952 and quickly spread around the world via nuclear power plants. After a nuclear explosion, residual radioactive dust begins to collect on the surrounding ground. It is relatively easy to find it in different types of sediments, as well as in the ice of the poles. Following the Chernobyl nuclear accident, an immense European territory was contaminated. The burial underground of nuclear waste drums from power plants is a sad and dangerous legacy that we leave to future generations. But it is the madness of men that worries. The atomic bomb can destroy humanity. All that will remain is deadly radioactivity and no archaeologist to study the consequences.



Nuclear energy throughout history

Around 450 BC, the Greek philosopher Democritus imagines that matter is made up of an assembly of "unbreakable, impassive and imperishable" particles: atoms (from the Greek atomos: which cannot be cut). However, it was not until the very beginning of the 19th century that the atomic theory was finally scientifically formulated. It was the English chemical physicist John Dalton who, following



Représentation chimique d'un noyau atomique. © PerOx, Wkipédia, domaine pub

work on the absorption of gases by water, was the first to come up with the idea that each chemical element is made up of atoms different from those of the other elements. A few years later (1869), the Russian chemist Dmitri Ivanovitch Mendeleiev established a table listing the known atoms according to their mass.

The characteristics of the atom

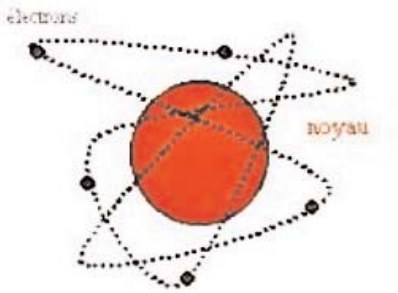
But, atoms are not the ultimate parts of matter. They are themselves composed of electrons, gravitating around nuclei. Nuclei are like bags, filled with balls of two kinds: protons and neutrons. Electrons, protons and neutrons are all three tiny particles, the first carrying negative electricity, the second positive electricity and the third carrying no electricity. Each atom contains as many electrons as protons in order to ensure its electrical neutrality. Each also contains a roughly equal number of neutrons and protons. There are simple atoms like hydrogen whose nucleus is made up of a single proton and others that are more complex. This is the case of uranium which contains 92 protons and 143 or 146 neutrons depending on the case. The same element can indeed be represented by atoms whose number of neutrons differs. These atoms are called isotopes of the element. Hydrogen isotopes, for example, have one proton and one electron and have zero, one, or two neutrons. These are light hydrogen (often simply called hydrogen because it is the most widespread), heavy hydrogen or deuterium, and tritium.

Discovery of radioactivity in 1896

In 1896, the French physicist, Henri Becquerel discovered, somewhat by chance, the phenomenon of radioactivity. Thanks to a photographic plate forgotten in a cupboard and impressed by uranium, he deduces the existence of an internal radiation in this metal which he baptizes uranic rays. It was Marie Curie who, after numerous studies on the properties of these rays, invented the name of radioactivity (from the Latin radius: ray). Lord Ernest Rutherford (English physicist and chemist) then explained in 1903, the nature of this radioactivity.

1934: discovery of artificial radioactivity

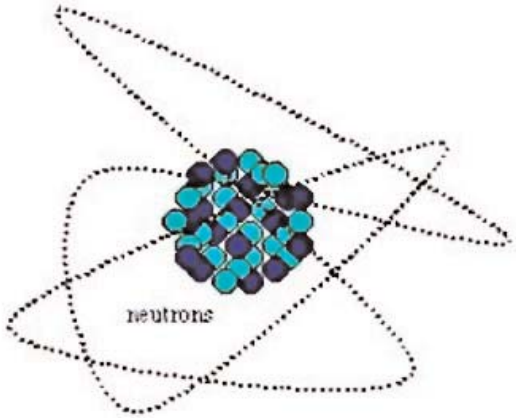
The year 1934 marked a turning point in the history of nuclear physics since it was at this time that Irène (daughter of Pierre and Marie Curie) and Frédéric Joliot-Curie discovered artificial radioactivity by bombarding an aluminum sheet with particles, creating new radioactive nuclei. The young couple thus shows that radioactivity is a much more general phenomenon than Pierre and Marie Curie had imagined, thirty-five years earlier.



Les atomes sont composés d'électrons qui gravitent autour d'un noyau lui-même composé de protons et de neutrons.

© Futura-Sciences.com

Atome d'Hydrogène : 1 proton et 1 électron.



Atome d'Uranium 235 : 92 protons, 92 électrons et 143 neutrons.

Nuclear fission

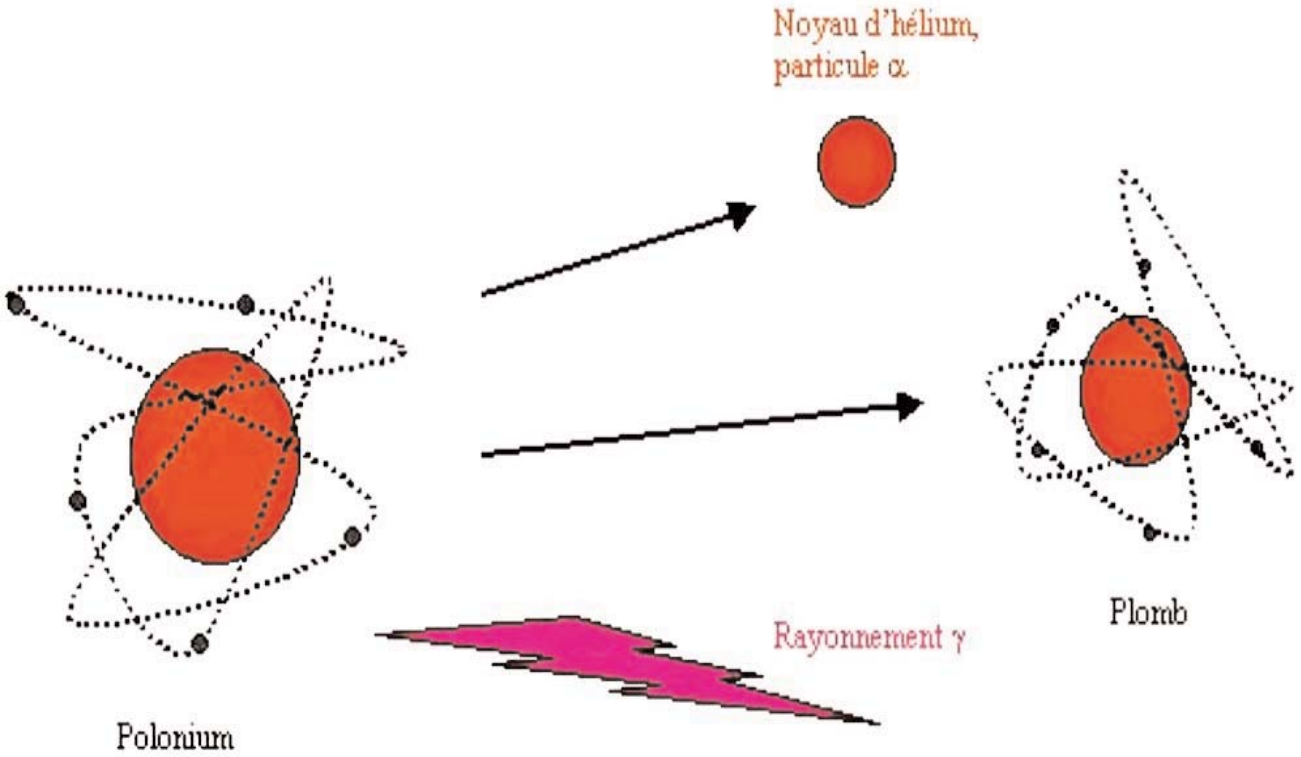
It was in 1938 that two German chemists, Strassmann and Hahn, highlighted the phenomenon of nuclear fission, showing that a neutron can break a uranium nucleus into two smaller nuclei. At the same time, three astronomers, Hans Bethe, Carl von Weizsacker and Charles Critchfield elucidated the mystery of the energy of stars, suggesting that these derive their formidable energy from internal reactions of nuclear fusion.

Stable and unstable atomic nuclei

Most of the nuclei of atoms that exist in nature are somehow immortal. They have been around for billions of years and will still be around billions of years from now. They are said to be stable. Other so-called unstable nuclei disintegrate after a certain time of existence.

This means that unstable nuclei transform spontaneously releasing particles whose flux is called radioactive radiation. Radioactivity is a spontaneous nuclear reaction.
Where does this difference come from ? Forces in action at the heart of matter. Positively charged protons tend to repel each other under the effect of a so-called electric force. However, neutrons and pro-

tons attract each other under the action of a very intense force: the nuclear force. As long as the two forces in play compensate each other, the atomic nuclei are stable but, if the nucleus presents too great an imbalance between the number of protons and the number of neutrons, the electric force ends up winning and the nucleus collapsing. disintegrate. The unit of radioactivity is the becquerel (Bq) named after the French physicist. One Bq corresponds to the transformation of one atom per second.

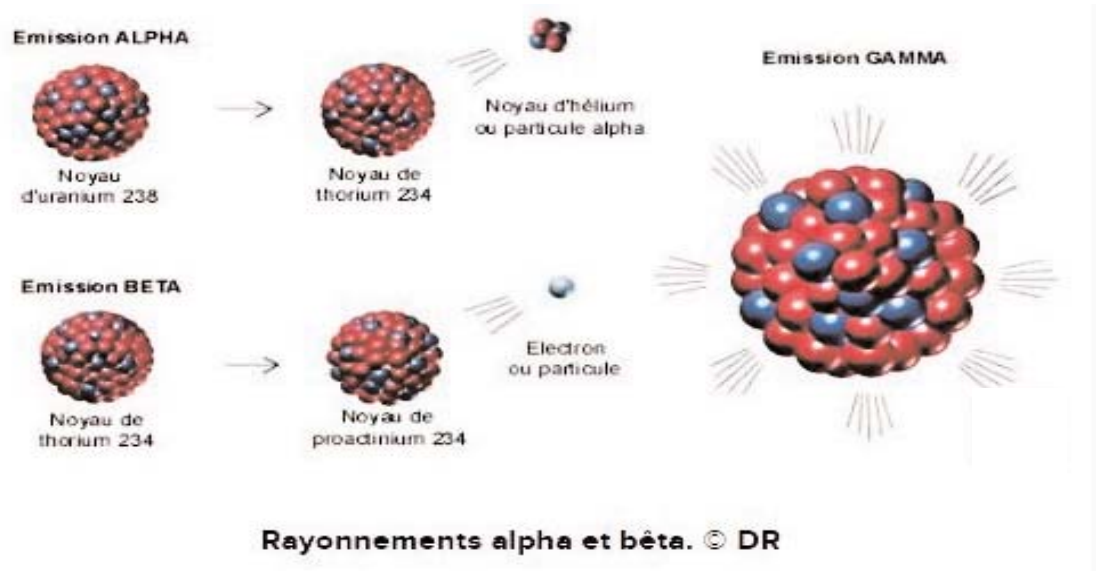


Cosmic rays (rays that arrive on Earth from the universe), the earth's crust, water, air, materials, the human body, food, etc. are at the origin of the permanent irradiation that we undergo. Milk, for example, has an activity of 50 Bq per kilo. This activity is very weak and completely natural. The activity of a child of 5 years is 500 Bq and that of an adult of 70 kilos is 10,000 Bq.

Since unstable nuclei decay, the number of naturally radioactive atoms decreases over time. The half-life (time required for the disintegration of half of the radioactive nuclei of an element) varies between 0.00000001 second and several million years. Thus, natural radioactivity is used as a dating tool. By assessing the amount of radioactive atoms in a sample, scientists can indeed estimate the age of fossils, etc.

Alpha, beta and gamma radioactive radiation

There are two categories of radioactive radiation: a (alpha) radiation corresponds to the emission of helium nuclei. a particles are highly ionizing (see box). A simple sheet of paper is enough to stop them and they are therefore dangerous only in the event of absorption (inhalation, ingestion, etc.);



Rayonnements alpha et bêta. © DR

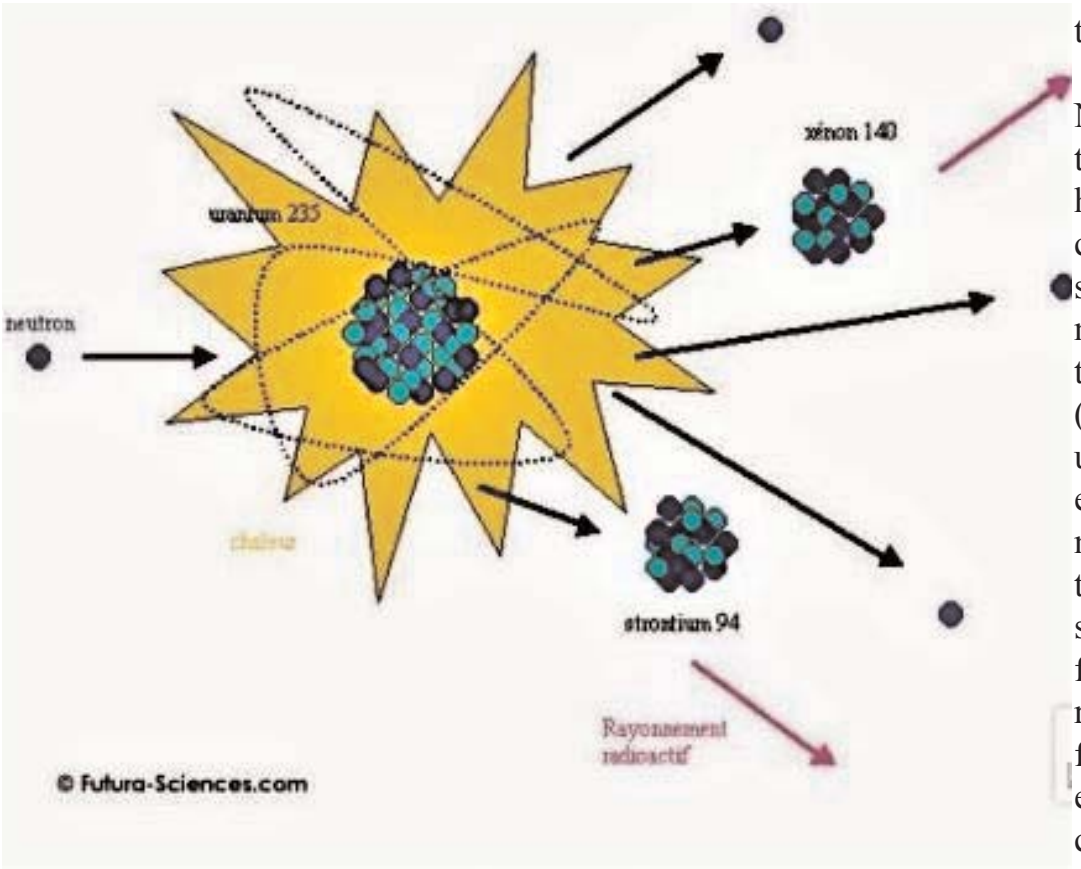
B (beta) radiation corresponds to emissions of particles such as electrons. The b radiation is less ionizing and therefore more penetrating. It is dangerous for the skin. A thickness of aluminum is this time necessary to stop it.

The ions created by the penetration of living tissue by radioactive radiation are mainly harmful to DNA and enzymes, structures essential to life. Many pioneers in the exploration of radioactivity have experienced it at their expense (superficial burns for Becquerel, leukemia for Marie Curie, etc.). However, the cells most sensitive to this radiation are the least differentiated cells. Thus, they can be used to treat and destroy cancer cells (brachytherapy and radiotherapy).

When we talk about nuclear, we often hear the words "fusion" and "fission". What is the difference ? Which chemical events are implemented?

Nuclear fission

Nuclear fission is the splitting of an unstable nucleus into two lighter nuclei and a few elementary particles. This bursting is accompanied by a release of heat, ie energy (see box). Spontaneous fission exists but is very rare. The only naturally fissile element is uranium 235. Under the impact of a neutron, the nucleus becomes unbalanced and is transformed into two lighter but still unstable nuclei called fission products. Upon impact with the neutron, these fission products are ejected at high speed. Fission nuclei are in most cases radioactive but their half-life is quite short. Fission releases tremendous energy. One gram of uranium 235 thus releases as much energy as the combustion of several tons of coal. The neutrons released by fission have a very high energy. If we manage to slow them down properly, they can induce new fissions and the reaction continues and accelerates. In nuclear reactors, the reaction is self-sustaining. But, if the number of neutrons present is allowed to increase, the reaction can become explosive, as is the case with the atomic bomb (bomb A).



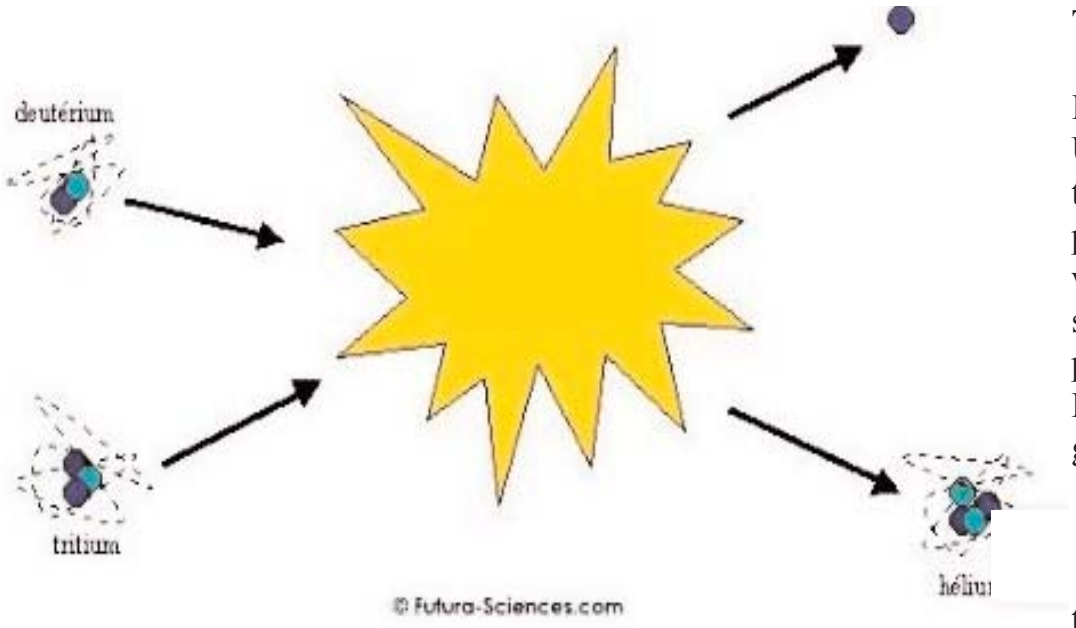
Le fission nucléaire. © Futura-Sciences

Nuclear fusion

It also happens that two or more light atomic nuclei unite to form a heavy nucleus. We then say that there is nuclear fusion.

Nuclear fusion is more difficult to achieve than fission because here you have to bring atoms so close together that they will stick together. For this, it is necessary to bring the material to a very high temperature (about 100 million degrees), under very high pressure. The energy released by this phenomenon is ten times greater than that released during fission. On the other hand, nuclear fusion does not produce radioactive waste since the fusion products are stable. The energy of stars comes from cycles of nuclear fusion reactions. Fusion is also exploited

in the thermonuclear bomb (H-bomb) for which A bombs are used as matches because their explosion makes it possible to reach the temperatures necessary to trigger fusion.



La fusion nucléaire. © Futura-Sciences

E which hides behind this mysterious formula (E - MC 2) is that any modification of mass (M) is accompanied by a release of energy (E). The term mass-energy equivalence means during a nuclear reaction that when an atomic nucleus splits into two smaller ones, there is a modification of the mass and therefore the release of sometimes colossal energy.

World War II and nuclear power

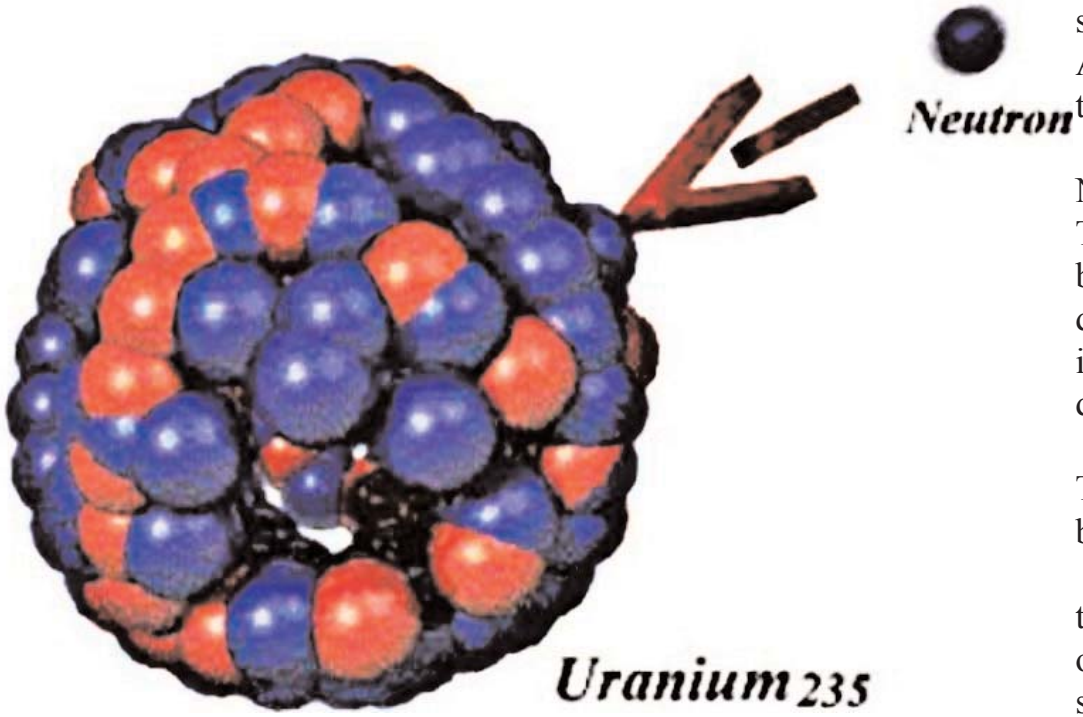
Then came the Second World War, which was to play a capital role in the development of research on nuclear energy. As early as 1941, several physicists who had emigrated to the United States mentioned the possibility of exploiting the power produced by nuclear fission. This is how the famous "Manhattan Project" was set up, bringing together thousands of technicians, engineers and scholars, all convinced of the merits of their research. In August 1945, two atomic bombs exploded in Hiroshima and Nagasaki, ending World War II.

The first nuclear power plants

It was not until 1951, still in the United States, that the first electricity of nuclear origin was produced. But it was the Soviets who, three years later, commissioned the first nuclear power plant of significant power. In France, nuclear power is undergoing a similar development. In 1945, the Atomic Energy Commission (CEA) was created, which immediately undertook the construction of several test reactors. In 1956, the first French reactor to produce electricity was commissioned. In the mid-1960s, nuclear energy entered an era of rapid industrialization, particularly in the United States and Europe. The 1973 crisis and the sharp rise in the price of oil further reinforced the trend. At the same time, fears linked to the exploitation of nuclear energy are giving rise to more or less lively opposition in part of public opinion in the countries concerned. In 2001, the 436 nuclear reactors in operation in 32 countries around the world supplied 17% of the world's electricity. In 2010, France produced 78% of its electricity from nuclear power.

In nuclear power plants, uranium 235 is most often used as fuel. But what is nuclear fuel? Nuclear fuel: why uranium?

The main fissile atoms are uranium 233, uranium 235, plutonium 239 and plutonium 241. Only uranium 235 is found naturally. It is therefore most often used as fuel in nuclear power plants.



A fuel is, by definition, a material that provides heat when it burns. The best known fuels are wood, coal, or oil. The uranium used in the reactors of nuclear power plants is called fuel because it releases heat, not by actual combustion but by fission.

Characteristics of uranium

Natural uranium, in the form of ore, is a mixture of two isotopes: uranium 238, by far the most abundant, and uranium 235, in the form of traces. However, it is precisely uranium 235, which undergoes nuclear fission. Enrichment is the operation which consists in increasing the proportion of uranium 235 in the mass of uranium.

The "burning" of a 7 gram uranium pellet can release as much energy as 1 ton of coal. The core of a nuclear reactor contains several million pellets. Each will stay there for three or four years. Transformations take place during this period: progressive consumption of uranium 235 and appearance of fission products. After a certain time, the fuel must therefore be removed from the reactor. It is renewed by thirds during "unit outages".

Nuclear power plant: how is electricity produced?
The production of electricity in the nuclear power plant is based on fission reactions which are self-sustaining and produce a permanent release of energy: the neutrons released during fission must in turn be able to strike other fissile nuclei, depending on the chain reaction process.

Two processes are used to increase the chances of encounters between fissile nuclei and neutrons:

the enrichment of uranium, which we have already discussed on the previous page; the slowing down of neutrons, by a substance which has the property of reducing their speed, without absorbing them: the moderator

The slowing down of neutrons by a moderator
The role of the moderator is therefore to slow down the neutrons which would otherwise be too energetic to effectively cause new fissions. The neutrons resulting from fissions, because of their high energy, move at high speed (20,000 km/s). They then pass too quickly close to the uranium atoms and the fission reactions are difficult to obtain. Hence the need to slow them down considerably (up to a speed of the order of 2 km/s).

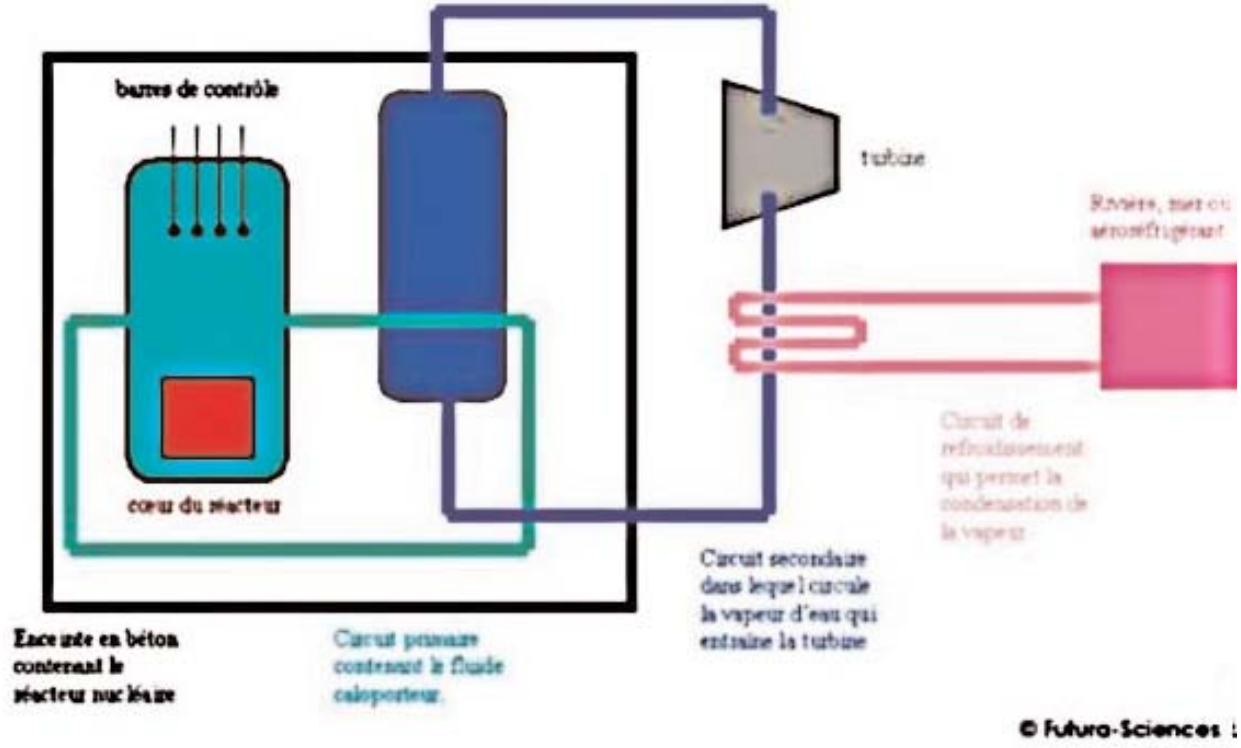
Neutrons are slowed down when they pass through matter which is composed of atoms whose nuclei do not absorb them. Indeed, like

balls moving on a billiard table where there are other balls, the neutrons lose speed by bouncing off the nuclei. This slowing down occurs rapidly when the obstacles are light nuclei with a mass close to neutrons such as those of hydrogen. Common moderators are graphite, ordinary water and heavy water. Heavy water, made up of water molecules whose hydrogen atom is replaced by a deuterium atom, heavier than hydrogen, has the best qualities sought in a moderator: it slows down neutrons well and absorbs them little. Unfortunately, its production is expensive.

The fission of uranium in the core of the nuclear reactor provides energy in the form of heat, generating water vapour. This drives a turbine and thus converts thermal energy into mechanical energy. The turbine, in turn, drives an alternator, which converts mechanical energy into electricity.

All these operations are made possible by the three water circuits of the nuclear power plant. The primary circuit in which a coolant fluid circulates recovers the heat released by the fission of uranium. The heat transfer fluid is a liquid (water or heavy water) or a gas (carbon dioxide or helium) which circulates at high speed in contact with the fuel elements. It must be able to conduct heat well and not absorb too many neutrons. The secondary circuit, independent of the first, receives this heat and produces water vapor to turn the turbine. The cooling circuit, meanwhile, circulates cold water to condense the steam from the secondary circuit again. These three circuits operate heat exchanges between them while remaining independent, which avoids any dispersion of the radioactive substance outside the plant.

The reactor core consists of a steel vessel containing the fuel and water from the primary circuit. Control rods (boron or cadmium), inserted through the lid of the vessel into the reactor core, are used to adjust the power of the chain reaction. They have the property of "eating" neutrons. Total immersion of the rods in the reactor core thus makes it possible to stop the chain reaction in two seconds. The assembly is enclosed in a sealed concrete enclosure which ensures containment.


barres de contrôle
turbine
cœur du réacteur
Circuit secondaire dans lequel circule la vapeur d'eau qui entraîne la turbine
Enceinte en béton contenant le réacteur nucléaire
Circuit primaire contenant le fluide caloporteur.
© Futura-Sciences

Circuit d'eau d'une centrale nucléaire. © Futura-Sciences

Nuclear waste

All human activity produces residues. The use of the radioactive properties of certain elements, whether for the production of electricity or in the fields of health, industry or research, is no exception to this rule.

We call radioactive waste (or nuclear waste) any material whose subsequent use is not foreseen and whose level of activity does not allow direct discharge into the environment.

Nuclear installations are not the only producers of radioactive waste. This is also the case for hospitals, certain industries, research centers and universities.

In nuclear power plants, during unit shutdown, a third of the spent fuel is removed and renewed. As it is very radioactive, the transfer operation is carried out under water: directly from the tank to a cooling pool, near the reactor. The water makes it possible on the one hand to trap the radiation and on the other hand to cool the pellets. They stay there for at least a year. Their activity decreases naturally: it is twelve times lower after one month of stay and thirty times lower five months later.

When the fuel is cooled and has lost much of its radioactivity, it is placed in a concrete or steel container. This operation is also carried out under water. The containers are then transported to the reprocessing plant in La Hague (Manche).

There are three categories of waste, depending on the half-life, the level of activity and the type of radiation emitted. You should know that 90% of them have a short life and a low to medium activity (about 100 Bq per gram of matter). The remaining 10% is split between long-lived, high-level waste and very low-level waste. All the radioactive waste produced each year represents relatively small quantities in volume: 1 kilo per inhabitant in France, compared to 2,500 kilos for industrial and domestic waste. The challenge facing researchers for the years to come is to succeed in bottling the Sun. In other words, to master nuclear fusion to produce clean and almost inexhaustible energy from hydrogen, like the stars.

The beginning of nuclear tests at the end of the 1940s could be the criterion marking the beginning of the Anthropocene, in connection with the deposit of synthetic radioactive material in marine sediments.
The sediments and corals of Beppu Bay could therefore be used as a reference to define the beginning of the Anthropocene. This is at least what the authors of the study published in the journal Scientific Reports propose.

Beyond the scientific aspect, the definition of the Anthropocene on the same level as the other geological periods highlights the power of the human impact on the Earth and its equivalence with respect to the major natural processes that have governed until this is the story of our planet. It confronts us with our responsibility and reminds us that human history is inseparable from that of the Earth.
From 1954, there are in fact deposits of plutonium. And this radioactive element is not natural. It is a synthetic element, produced by man and discovered for the first time in 1940 following the bombardment of a uranium 238 atom with deuterium. The nuclear tests which followed, from the beginning of the 1950s, therefore generated fallout of plutonium which was trapped in the marine sediments. What better marker to date the beginning of human impact on the environment and the control of complex physical processes?

The age of oil

Petroleum has been known and used since ancient times. It forms outcrops in places where it is abundant underground; these outcrops have been used in many ways: caulking boats, cement for paving streets, a source of heat and light, and even pharmaceuticals. Its distillation, described from the Middle Ages, gives an additional interest to this product for oil lamps.

From the 1850s, oil was exploited and used industrially. It was operated in 1857 in Romania, in 1859 in the United States, in the state of Pennsylvania, and in 1861 in Boryslav in Ukraine. From 1910, it is considered a strategic raw material, at the origin of the geopolitics of oil. The period 1920-1970 is marked by a series of major discoveries of deposits, particularly in the Middle East, which is the object of all desires. The dependence of developed countries on this raw material is such that its greed has triggered, or influenced the course of several wars; the civil wars against the backdrop of the oil field can no longer be counted. The oil supply of belligerents has several times influenced the fate of weapons, as in the two world wars. Civil wars against the backdrop of oil fields are countless. In doing so, oil has become indispensable and therefore strategically very sensitive. Oil is the largest international trade in fossil materials by value and volume. It has a significant weight on the prices of the financial stock exchanges of the planet.

Markets for petroleum products are also developing; in addition to fuels such as gasoline, diesel and heavy fuel oil, which accompany the growth of transport as a whole, the oil industry generates a myriad of by-products, including plastics, textiles and artificial rubber , dyes, shampoo, cosmetics, synthetic intermediates for agricultural chemicals such as herbicides and pesticides and pharmaceuticals. Having become essential to daily life in most developed countries, oil has a significant social impact.

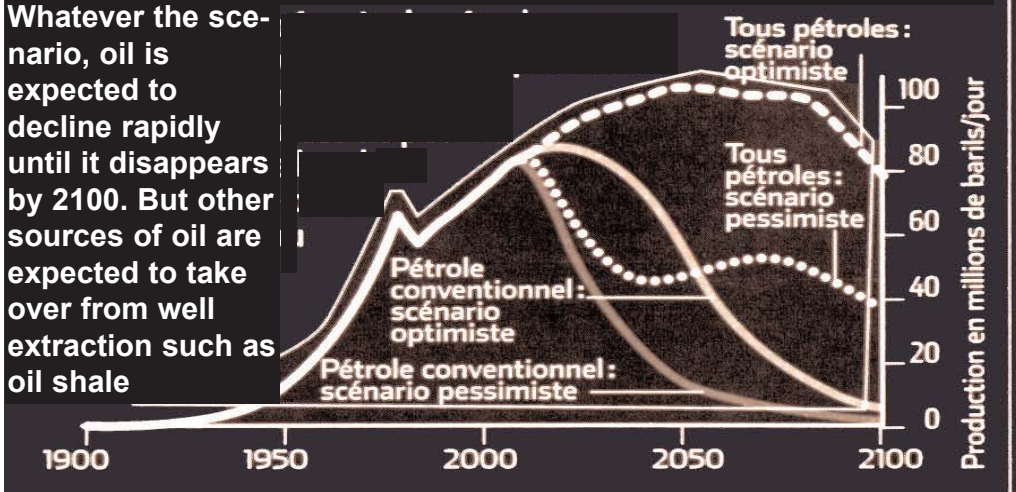
The development of the oil industry provided the liquid fuels that enabled the second industrial revolution and therefore significantly changed the course of history. In this sense, oil is truly the successor to coal, which made possible the first industrial revolution. Its use is also a source of controversy, because it causes major damage to the environment: global warming, pollution.

The most worrying environmental impact of oil is the emission of carbon dioxide at the various stages of its production, transport and above all its consumption, especially in the form of combustion as fuel. Without forgetting the destructive oil slicks of the marine and terrestrial environment.

Sources of energy

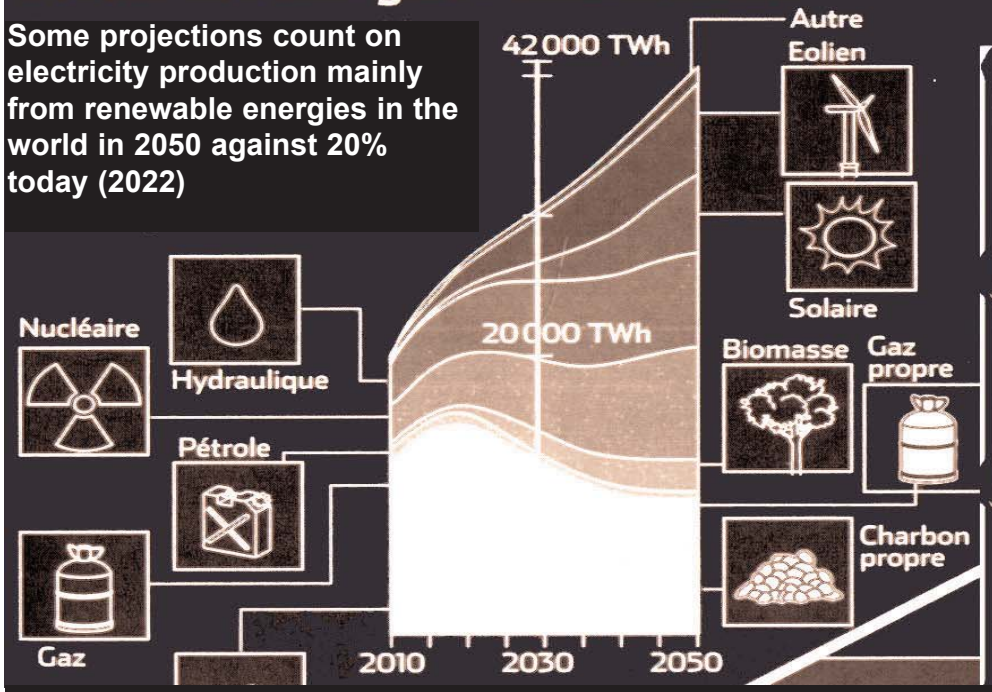
The end of conventional oil

Whatever the scenario, oil is expected to decline rapidly until it disappears by 2100. But other sources of oil are expected to take over from well extraction such as oil shale



.The rise of renewable energy

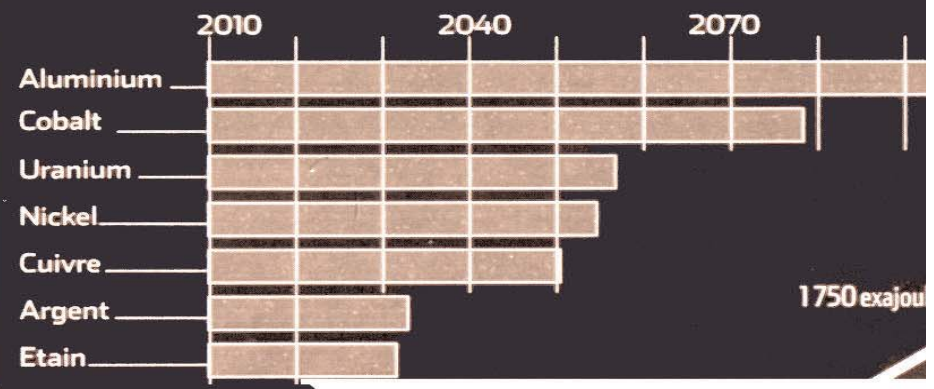
Some projections count on electricity production mainly from renewable energies in the world in 2050 against 20% today (2022)



Minerals

New deposits will have to be discovered.

For many minerals, the deposits that can be exploited today will, at the current rate of consumption, only cover a few decades of demand. An exploration effort should be initiated and new exploitation technologies developed.



PETIT MANUEL DE NEOCOLONIALISME
MAINTENANT QUE NOUS AVONS DETRUI
VOTRE PAYS, VOUS POUVEZ NOU
PAYER POUR LE RECONSTRUIR
VOUS POUVEZ NOUS PAYER
EN NATURE, PAR EXEMPLE
EN PETROLE !

Small handbook of neocolonialism -
Now that we have destroyed your country, you can pay us to rebuild it! - You can pay us in kind, for example in oil.

LAMBORGHINI
Ford
Radical
GEMBALLA
ROLLS ROYCE
CHEVROLET
Hennessey
MINI
Koenigsegg
NISSAN
LOTEC
CHRYSLER
KOENIG
DODGE
Ultima
LINCOLN
INGENFELTER
MITSUBISHI MOTORS
ROVER
JAGUAR
MARCOS
Leading Edge
HOLDEN
CAPARO
RUF
Ascari
MAYBACH
PANTHER
MASERATI
DAEWOO
SEAT
TVR
LAND ROVER
Noble
INVICTA
VENTURI
SALEEN
MG
PAGANI
ACURA
PLYMOUTH
LISTER
EATON

The age of silicon

Although silicon oxide is extremely common (silicates make up about 90% of the earth's crust), production of the pure element, which is an essential component of almost all electronic objects, has only been possible on a large scale. scale only from 1850. Silicon, whose particular properties made it possible to create new materials making it possible to create new technologies. From the transistor to the electronic chip, a whole profile universe: computer, Iphone , home automation, etc.

Current engineers and inventors have always been on the lookout for the technological possibilities offered by new materials. So the types of buildings, devices, semiconductors, and infrastructure we can construct depend as much on the materials we have at our disposal as on other factors like energy, labor, or ingenuity. In 10,000 years, an archaeologist looking for information on our civilization would be very excited to discover pure silicon at the origin of the computer revolution.

The age of plastic

Plastic "has redefined our material culture and the objects we leave behind," and archaeologists of the future will find it in stratified layers in our dumps. Of all the era-defining materials, plastic is "the most ubiquitous" - though it's also the hardest to link to significant social change. "There is a lot more plastic in the world than people realize," she told us, including in paints, wallpapers, carpets and furniture coverings. There is also a high probability that plastic will become the primary material for defining the Anthropocene. From a geological perspective, " plastic spread rapidly across the world," Waters told us, and even if it eventually breaks, "its components, like dyes and plastic parts, would be probably still preserved. Which means that we could not only be living in the age of plastic, but also in the age of plastic. Remains of the oceans, increasingly damaged and soiled by plastic waste, which nevertheless constitute the very source of life on Earth. We speak today of a "7th continent of plastic" evolving in the northern Pacific Ocean, the size of a third of the United States or six times the size of France. Of course, it is more of a "plastic soup " than a continent, made up of scattered large pieces of waste and above all a myriad of tiny plastic fragments - with a diameter of less than 5 mm, in suspension at the surface or up to 30 meters deep. And that fish or dolphins often swallow, confusing them with plankton, before dying of suffocation.

PLASTIC WASTE

Our planet is overwhelmed by billions of tons of plastic waste that has accumulated since the 1950s. A situation that is getting worse in the absence of effective recycling, according to a new study.

Researchers from the universities of Georgia and California have determined that 8.3 billion tons of plastics were produced between 1950 and 2015, of which 6.3 billion tons became minimally biodegradable litter. Only 9% of them have indeed been recycled, 12% have been incinerated and 79% have accumulated in landfills or in nature, in particular in the oceans, where more than 8 million tons of plastics are dumped every year. the years.

The share of plastics in solid waste from municipal landfills in developed and middle-income countries jumped from 1% of the total volume in 1960 to more than 10% in 2005. If the current rate continues, there will be some 12 billion tonnes of plastic waste in landfills or in nature by 2050, the equivalent of 35,000 times the mass of the Empire State Building in New York, predict the authors of the study which has just appeared in Science Advances.

"Most plastics are not truly biodegradable, so they could persist for hundreds or even thousands of years in the environment," says Jenna Jambeck, co-author of this research and assistant professor of engineering at the University of Georgia Our estimates show the need for more critical thinking about the materials we use and how we manage our waste."

According to this study, which compiled production statistics for resins, fibers and additives from a variety of industrial sources, global plastics production increased from 2 million tonnes in 1950 to 400 million tonnes in 2015, i.e. more than most other man-made materials.

The most spectacular figure is this: in 2014, the ratio, by mass, between plastic waste in the ocean and fish was 1 in 5, in 2025 it will be 1 in 3 and 1 in 1 in 2050.

Each year, 8 million tonnes of plastic waste reach the ocean, where this mass accumulates by fragmenting. If efforts are made to increase the share of recycling, explains the report published for the Davos forum, this flow will reduce but not be canceled and the quantity of plastic in the ocean will continue to increase. The solution is systematic recycling.

According to the report, the best current studies point to a total of 150 million tonnes of plastic in the ocean today. It is in a very fragmented form, with, according to a 2014 study, 269,000 tonnes of large pieces floating on the surface and it is found as far as Antarctica. The plastic load of the ocean should climb to 250 million tonnes in 2025 and, therefore, 750 million tonnes in 2050. The amount of waste will therefore, according to these figures, be multiplied by three in 25 years, which can surprise because, at the same time, the production of plastic will only triple. The authors explain this divergence by the fact that most of this growth will go to poorly recycled products, in particular packaging, which today absorbs 26% of production. Half of all plastics become waste after just four years or less of use.

Recycling is the only solution, according to the authors, whereas today it only represents 14% of production, given the various losses at all levels of the cycle. Above all, the report points to the huge single-use packaging market, containers of all kinds in which we find 62% of everything we buy and 32% of which goes into nature.

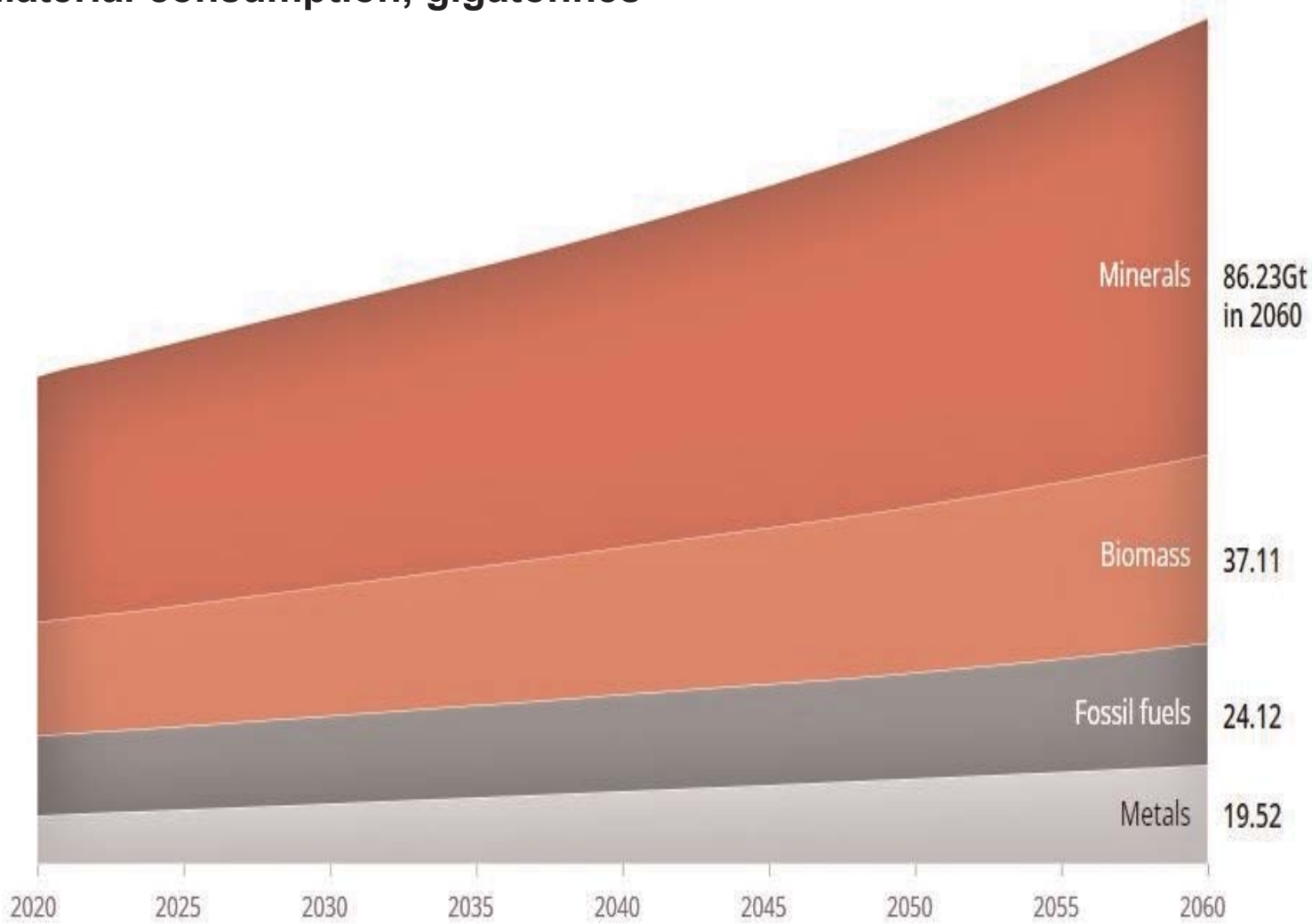
PLASTIC WASTE MANAGEMENT

Our patterns of production and consumption call for more efficient and environmentally responsible management of materials throughout their life cycle, from production to consumption and disposal.

This goal includes key and ambitious targets, such as improving the way we use and dispose of minerals, fossil fuels and metals, reducing food losses throughout the supply chain and limiting the production of plastic waste that accumulates in nature.

MATERIAL CONSUMPTION IS EXPECTED TO INCREASE BY APPROXIMATELY 15% BY 2030 AND BY 75% BY 2060

Material consumption, gigatonnes

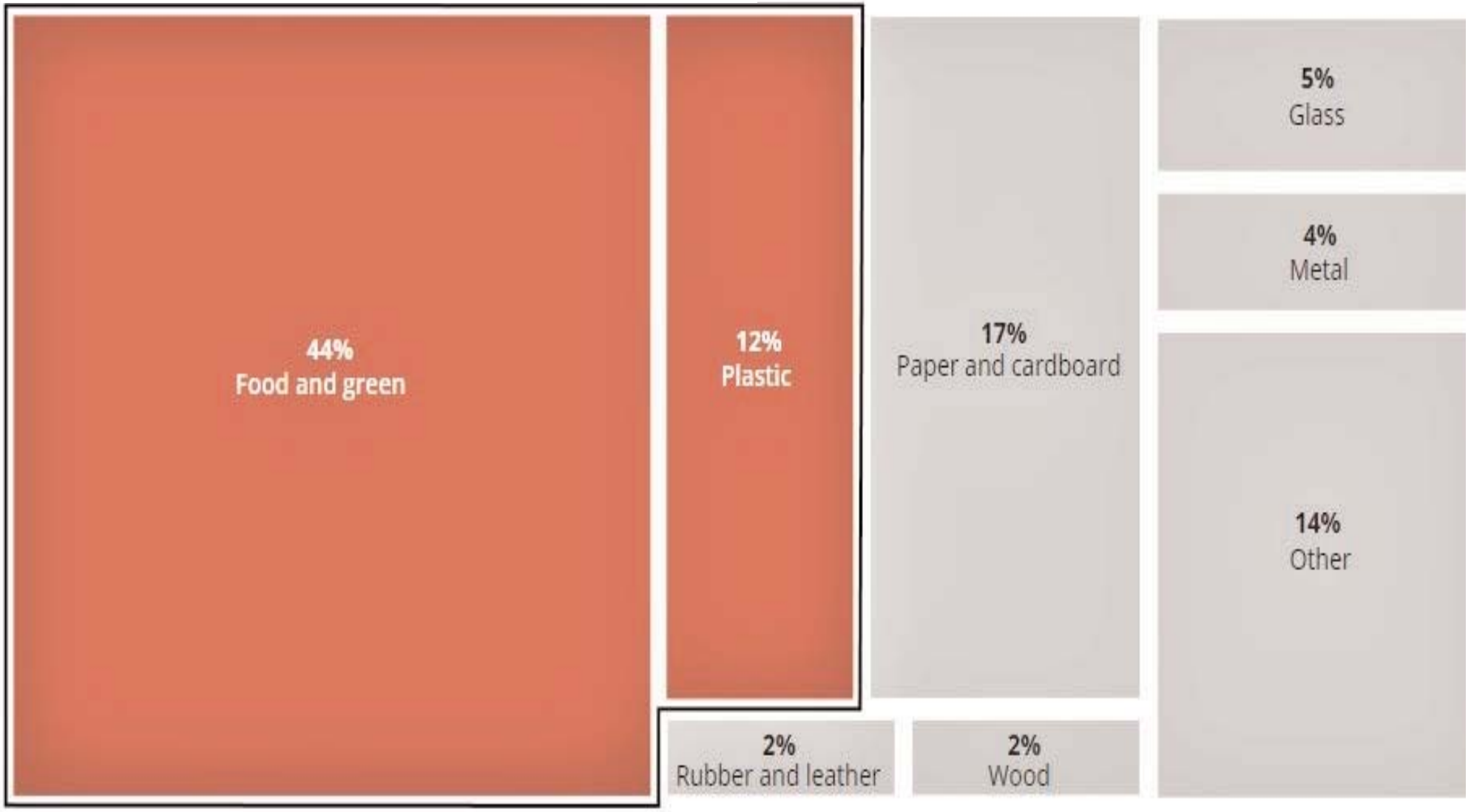


The consumption of material resources in the world is set to intensify due to economic growth and the rise in per capita income, but also to a world population increase estimated at 3 billion inhabitants by 2050. Globally, this increase is expected to reach 15% by 2030 and 75% by 2060, up to a volume of 167 billion tonnes. The development of low- and middle-income countries that aspire to match the standard of living of high-income economies could be an important driver of material consumption. In the absence of targeted structural or technological policies aimed at curbing resource exploitation or promoting recycling, the increase in materials use will not decline, to the detriment of the environment through extraction and the resulting waste pollution.

Plastics account for one-fifth of global waste and are causing growing environmental concerns. Although large-scale plastic production didn't begin until the 1950s, plastic products are now

FOOD AND PLASTICS WASTE REPRESENT MORE T HAN HALF OF THE GLOBAL WASTE VOLUME

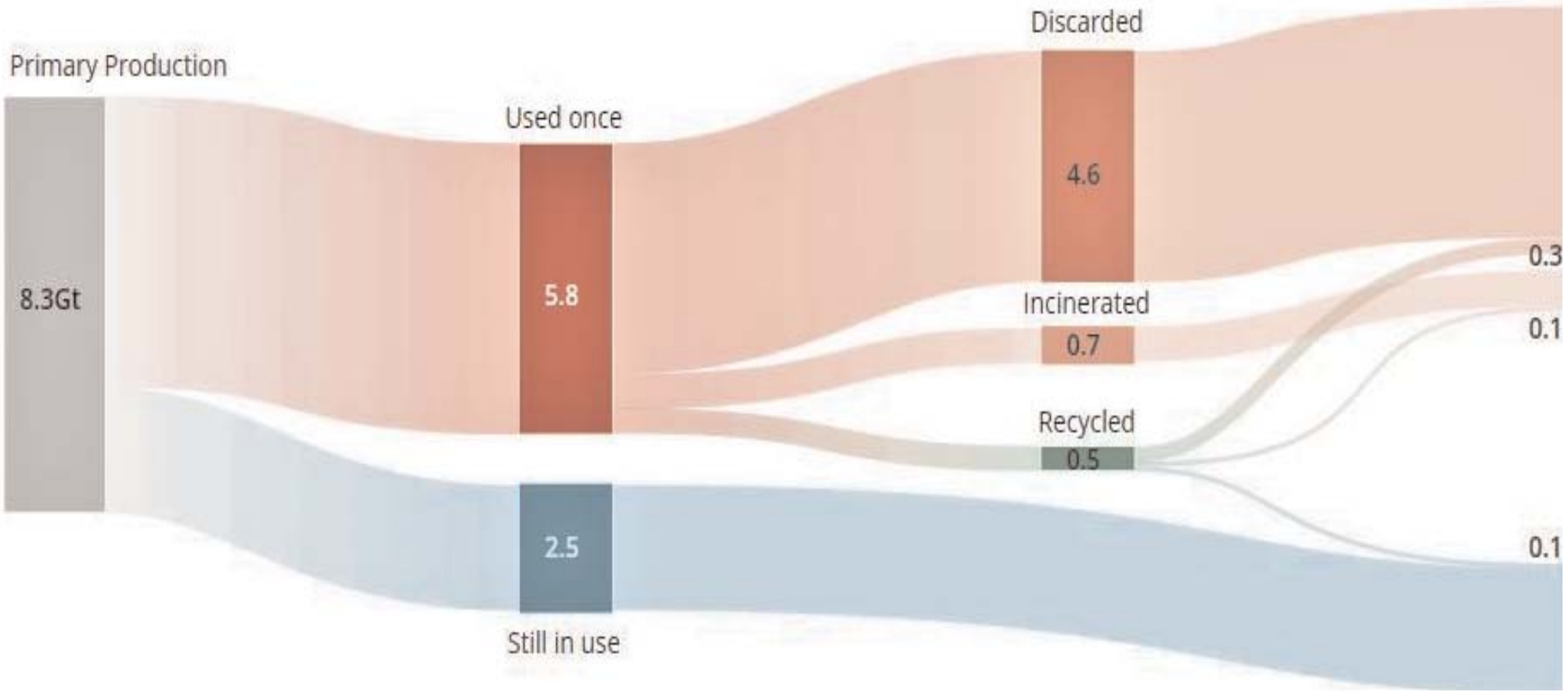
Composition of global waste generation (%



Source : Banque mondiale. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050

MORE THAN HALF OF ALL PLASTICS WERE DISPOSED OF AND ONLY 6% OF THEM WERE RECYCLED

Fate of plastic production in gigatons



everywhere, from storage containers and packaging to electronic devices. From 1950 to 2015, more than 8.3 billion tons of plastic were produced and most of it was used only once. More than two-thirds of all plastics ever made have been discarded, ending up in landfills and contributing to environmental pollution. Only 6% of all these plastics have been recycled.

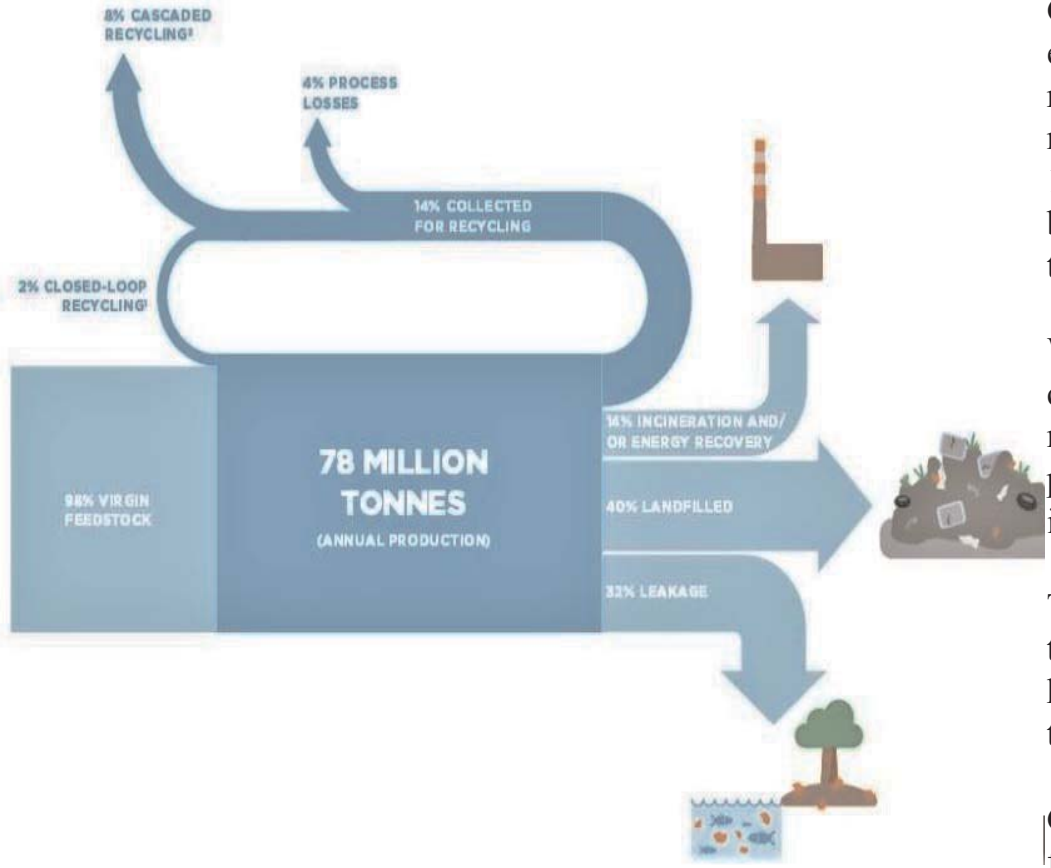
Non-recycled packaging

The authors let the planet's managers know that the mass of this lostplastic represents a value of 80 to 120 billion dollars (i.e. around 92 billion euros at the current price), that is to say 95% of the packaging products market. The report drives the point home by evaluating the total cost of this waste at 40 billion dollars per year, taking into account the various pollutions it induces.

Seabirds, moreover considered a good indicator of marine pollution. These animals directly ingest plastic waste, more or less large and of any kind, which they take for food. They can also ingest it acciden-

tally, in the form of smaller pieces, stuck on algae or already ingested by their prey. These objects can be dangerous for them in two ways: by risk of suffocation or by the ingestion of products that can be toxic. Until now, the risk had only been identified in the coastal regions, and imperfectly.

Chris Wilcox, Erik Van Sebille and Britta Denise Hardesty went further to measure this risk on a global scale, including for seabirds, and to estimate it for different regions. These biologists proceeded



in two ways, taking into account the food habits of 186 species (42 genera, 10 families), the quantities of waste known in different places around the world and the evolution of the quantities of plastic materials produced.

99.8% of seabird species impacted by 2050

The researchers also analyzed the literature and analyzed studies conducted between 1962 and 2012 on 135 species of seabirds, which showed that the individuals of 59% of them regularly ingest plastic. "By standardizing the data, we estimate that the proportion would be 90% of individuals if these studies were carried out today", explain the authors in the summary of the scientific article published in the journal Pnas.

Given the increase in global plastic production (a doubling every eleven years, the authors point out), this proportion will reach 99.8% of the species concerned in 2050. These values are not only theoretical since they corroborate the observations: in 1960, 5% of birds passing through the hands of scientists harbored pieces of plastic in their digestive tract, while the proportion reached 80% in 2010.

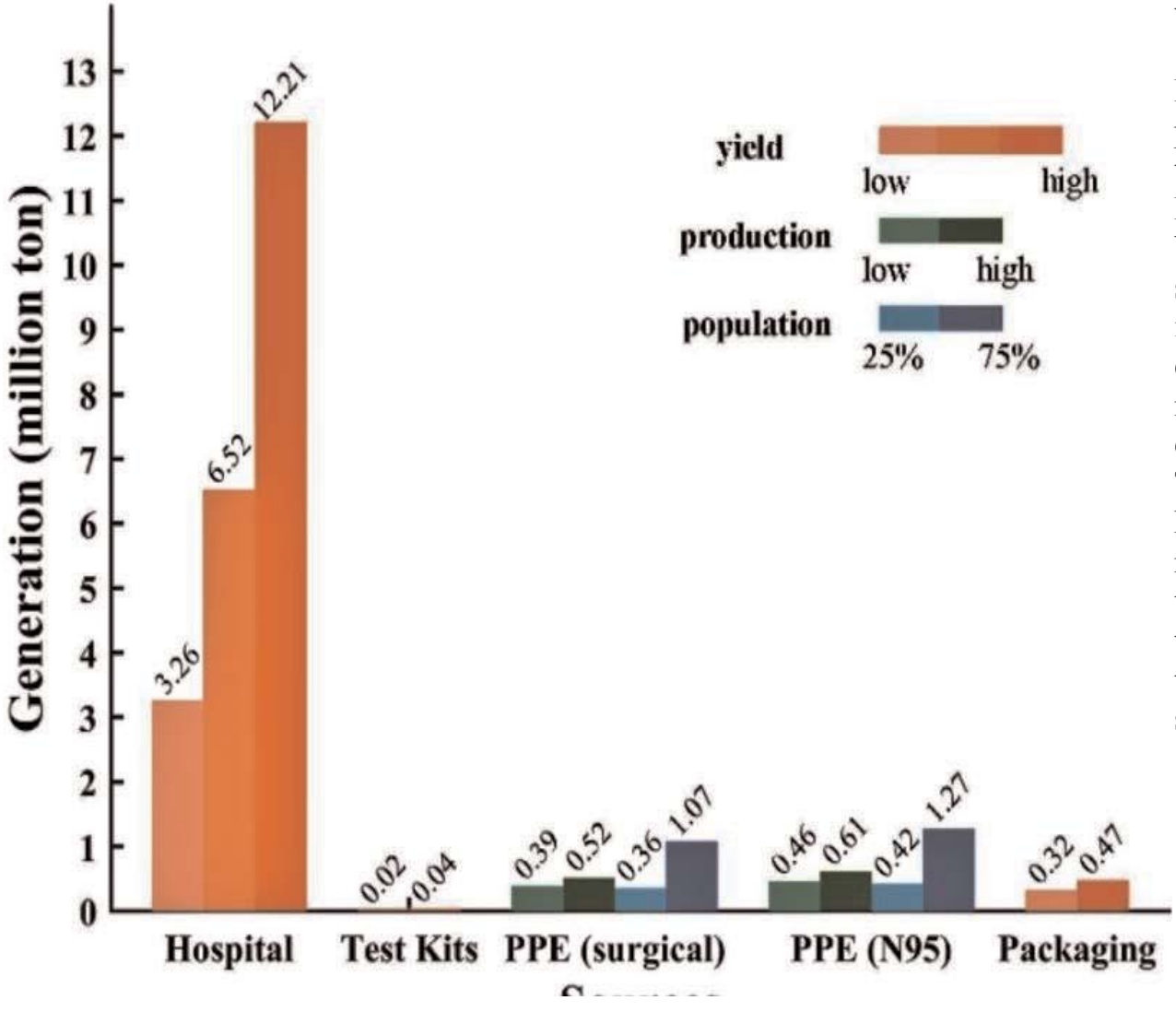
Within the oceanic gyres, where the debris, disaggregated, concentrates, animal life is poor. According to him, two species are more affected: penguins and albatrosses. Britta Denise Hardesty points out that scientists have found nearly 200 pieces of plastic in the stomach of a single bird.

The COVID-19 pandemic has further boosted plastic consumption, as single-use items - masks, personal protective equipment kits and bottles of sanitizer - have become essential to prevent the spread of the disease.

Globally, the sale of disposable masks has increased 200 times, from 800 million units in 2019 to 166 billion in 2020, leading to a dizzying increase in plastic waste. Curiously, and despite the explosion of online commerce, packaging represents only 4.7% of this additional waste.

The hospital is by far the main source, with 87.4% of the total. The problem is that nothing has been planned to manage this additional influx of waste, deplore the researchers in their study published in the journal PNAS. As a result, 25,000 tons of plastic are expected to end up in the oceans and accumulate on beaches, in marine sediments, or in the famous "plastic vortices" floating on the surface in some places. In 2020, a previous study had already estimated that 1.56 billion masks ended up in the oceans last year. Researchers are calling for better waste management, especially in Asian countries where most of the plastic comes from. They also recommend a "rational" use of disposable products, the development of recycling channels as well as new, more ecological materials.

In addition, due to lockdowns and physical distancing measures imposed in many countries, the delivery of meals, parcels and other basic necessities has become widespread around the world, which has led to an increase in plastic waste. In Thailand, for example, the volume of waste has increased from 1,500 to 6,300 tonnes per day, and it can be assumed that this increase is attributable to the sharp increase in deliveries of food products. With 75% of plastic waste filling landfills or ending up in the oceans, consuming and disposing of this waste responsibly is critical to protecting life on land and water.

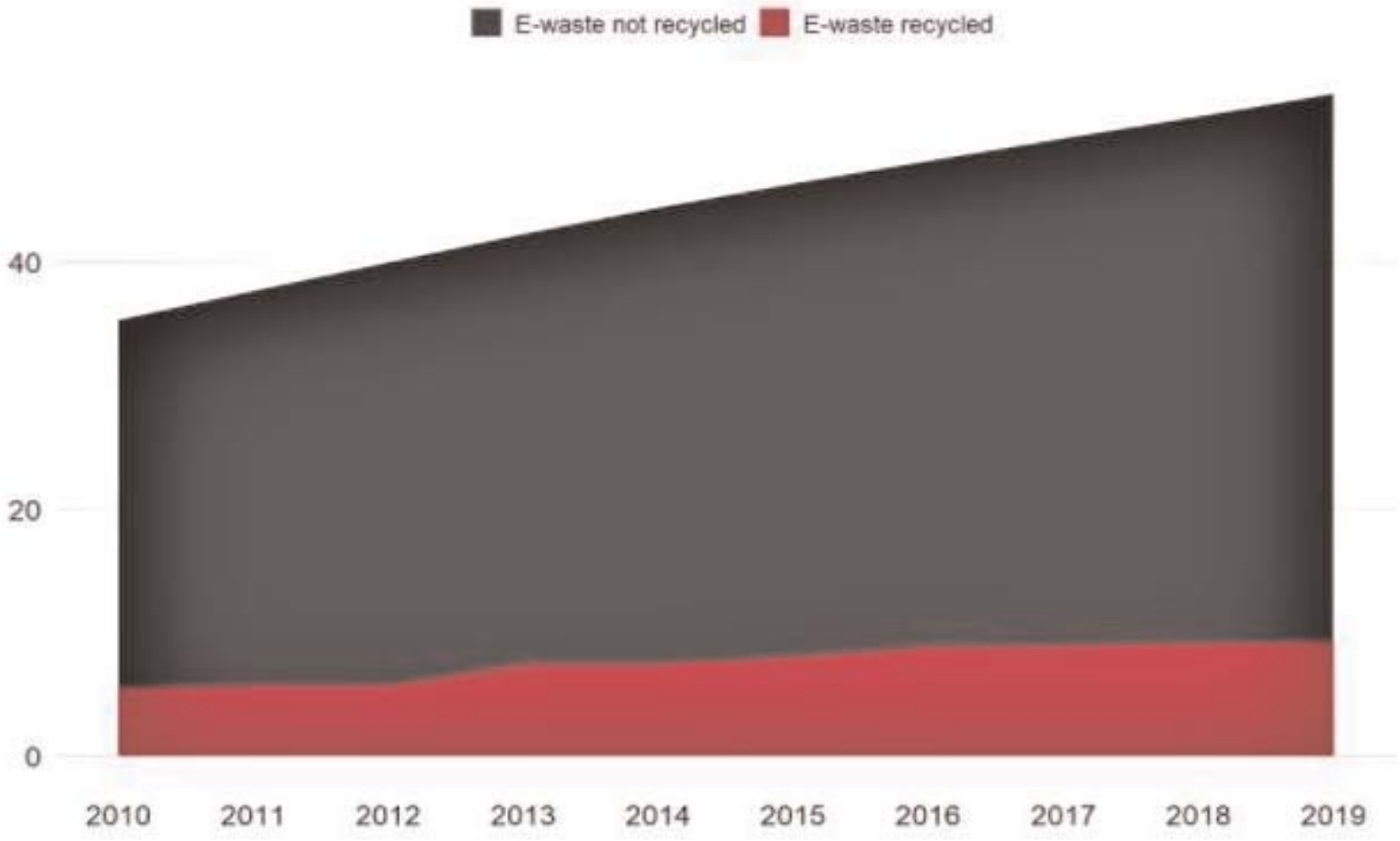


Responsible consumption and production of plastics can be achieved through better production and waste management strategies. Dematerialization, substitution and improved biodegradability are some of the most common strategies in this area. To better manage waste, it is necessary to set up an efficient plastics reuse economy, based on efficient collection and treatment, in order to reduce dispersion in the natural environment. The strategy put in place by Tunisia is an example of success. This country has introduced a system of extended producer responsibility and financially incentivizes individuals and informal collectors to collect plastic waste and deliver it to treatment centers. In addition to increasing plastic recycling rates, this strategy has created jobs and micro-enterprises.

THE VOLUME OF ELECTRONIC WASTE IS INCREASING BUT THEIR RECYCLING IS NOT PROGRESSING AT THE SAME RATE

Most electronic waste ends up in landfills, thus polluting soils and groundwater with harmful effects on health and the environment.

Electronic waste in the world in tons

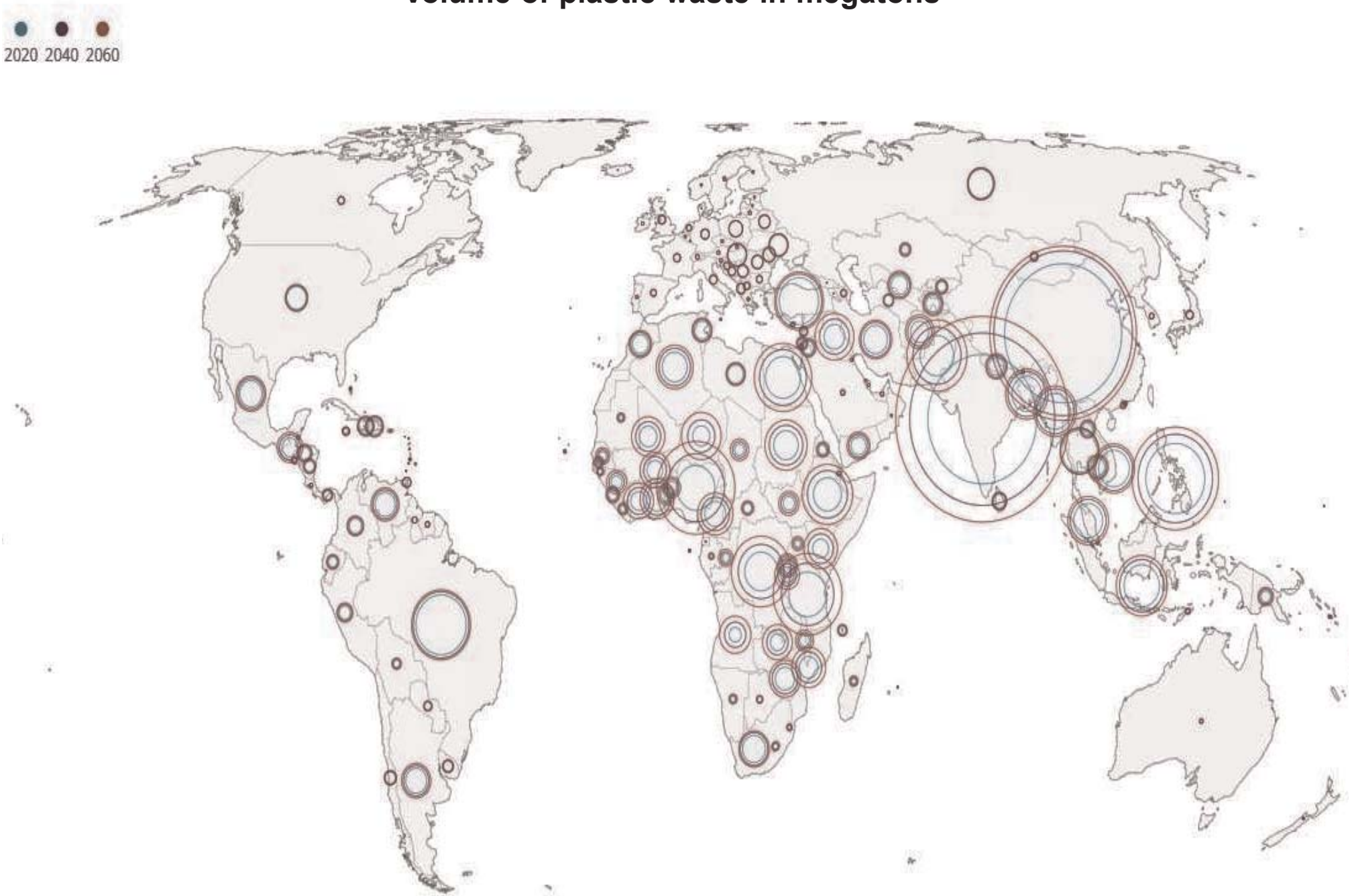


There is also a need to invest more in waste management, especially in low-income countries where plastic production and consumption will increase the most. Stronger recycling value chains and improved financial efficiency of solid waste management are key to ensuring systems improve. Governments can also help reduce plastic waste by banning or taxing single-use products or packaging and implementing other types of regulatory controls.

Even before the COVID-19 pandemic, governments and businesses were looking to reduce plastic waste. In 2019, more than 180 countries ratified an amendment to the UN's 1989 Basel Convention to include plastic as hazardous waste, and in the meantime, industries around the world pledged to increase plastics by 22%. share of recycled plastic in packaging by 2025.

POOR MANAGEMENT OF PLASTIC WASTE: ESTIMATE FOR TODAY OR FOR TOMORROW

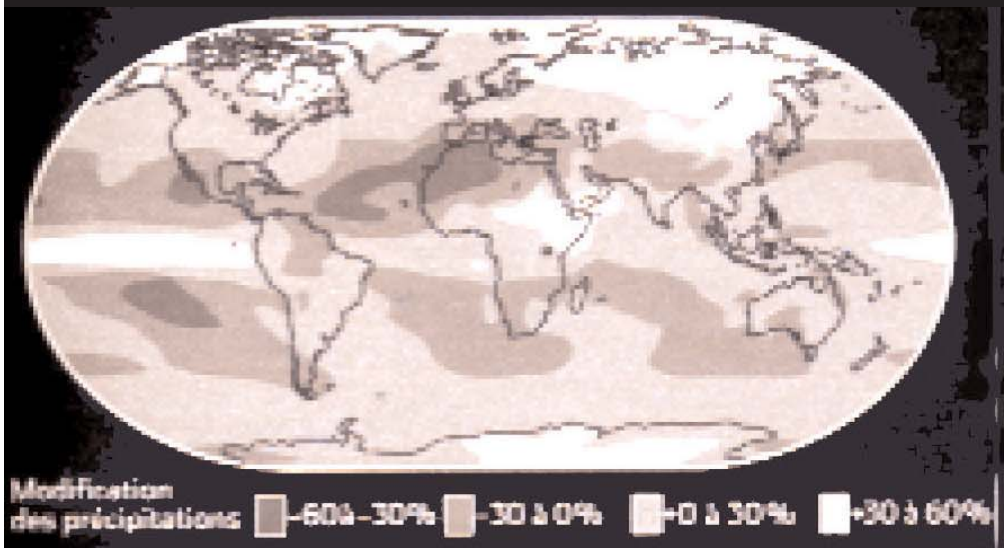
Volume of plastic waste in megatons



Atmosphere

An increasingly unbalanced precipitation regime.

The upper and middle latitudes of the Northern Hemisphere should receive more and more rain than today while the regions further south will become more arid.



The number of category 4 or 5 hurricanes (winds greater than 210 km/h) expected in the Atlantic

50

This is the number of additional days of heat wave (night temperature above 20 C) that will have to be endured in 2100 across the globe

Continents

A moving fire hazard

Increased risk of forest fires in Europe and North America

110 micrograms

It is per cubic meter of air, the concentration of ozone which, on the French territory which could be raised in the summer of 2100 (the double of today)

39 %

This is the proportion of land that could experience unprecedented extreme climatic conditions.

The social consequences of climate change

The climate is one of the components of the natural environment which has exercised the most influence in the history of traditional societies, even if the French historical school has for a long time emphasized the importance of the weight of economic conditions. on societal changes.

Before the time of writing and following the Englishman Alex Chepstow-Lusty and his group, we draw a parallel between an equivalent of the Medieval Climatic Optimum around the year one thousand in Europe and that approximately observed in the Central Andes with the rise of Andean civilizations, from the analysis of lake cores around Cusco where the intensification of forestry and agronomic practices is attested with the multiplication of alders and terraces.

The parallel between the fall of Tiwanaku and the Maya cities seems more debatable to us. This great pre-Inca empire would have disappeared in the 13th century, after nearly two millennia of existence following a great drought which would no longer have allowed very productive agriculture made from a complete and complex system of water control. water, which served as much to bring water (irrigate) as to withdraw (drain), around Lake Titicaca (ados or camellones) and to which was added the cultivation of corn, in the valleys. It is the thesis of the abrupt changes in the climate which determined no less brutal changes in highly structured societies, and therefore not very adaptable or not very flexible, like the city-states of the Mayas.

It may appear in the Andes to be in contradiction with that of the complementary exploitation of the greatest number of ecological stages, a thesis developed by John V. Murra and which has made many disciples in research. Why did empires not rely on their wettest and therefore always largely productive part during their periods of crisis, something that was possible for a large empire such as Tiwanaku, but more difficult for city-states with often cramped territories and to the uniform soils of the Mayas?

There is also in South America, a particularity well known since the time of the Spanish conquest, that is to say the more or less regular appearance of El Niño episodes (because the phenomenon of warm waters on the surface appears most often around Christmas hence, his name of the child Jesus). These episodes are now attributed to a global impact, but its most characteristic signal remains torrential rains on the Pacific and desert coast of South America, and more precisely in northern Peru, as on the Galapagos archipelago. In history, the war of 1878-79 is famous, which was contemporary with the War of the Pacific (1879-84) which opposed Chile, Peru and Bolivia and which led to a tragedy in the last two countries because, at the cost of the defeat , were added the dead of hunger and the vagabonds thrown on the paths without a living soul by a drought that lasted more than a year.

However, the El Niño episodes of 1800-05 and 1982-83 and the great concomitant droughts in the Andes were not left out because, at the first, we can follow the fall of the Spanish empire in the Andes with the first uprisings separatists of 1809 and, in the second, the fall of the dictatorships and the return to democracy in Bolivia in the years after 1982. Often, the epidemics were the consequence of droughts like that of 1611-12 known from Quito in Ecuador.

2 - The climatic consequences of changing societies

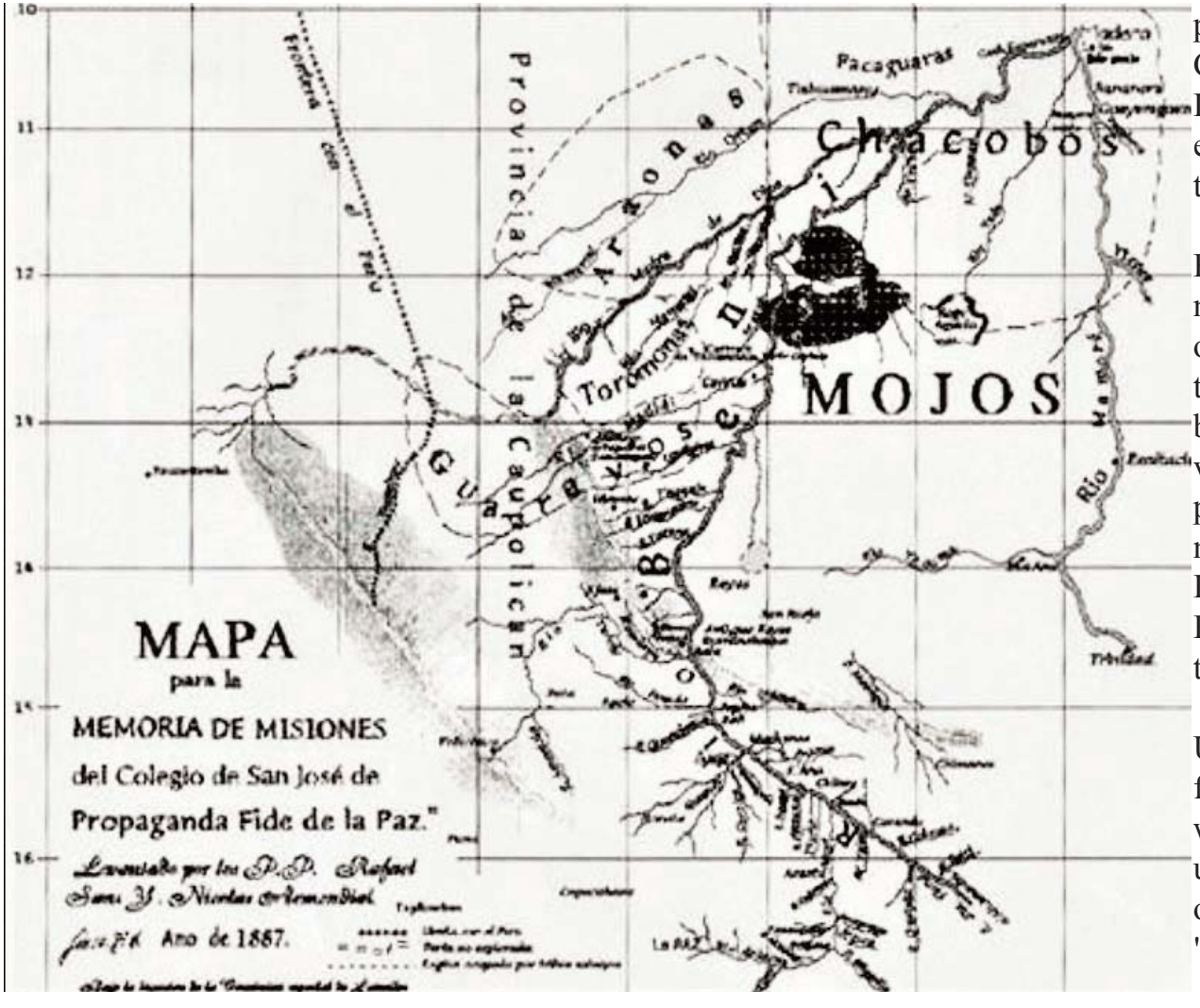
There is a specificity of Latin America in climate history stemming from its colonial history: the weight of religion in science; the importance of the mining sector which often settled in high mountains near deposits of gold, silver and precious stones; the interest of explorers' stories, etc.

t was the money boom that led to the creation of a series of boom towns, including Potosi at 4,000 meters above sea level. Europe will

see its volume of money increase tenfold and therefore experience economic take-off. To do so, the Spaniards imported or perfected the best of the technology of the time. The amalgamation of silver requiring a lot of water, they dug canals and dams to supply the mining industry. Hence, an important source of information because if this water were to run out, silver production would have been in danger and there was an exchange of correspondence between the various bodies, including those of the State which was, first and foremost, interested in monetary production in all cities also producing gold and precious stones.

The quasi-monopoly of the monks until the XVIIIth century in the field of studies is the characteristic of this world which can seem closed on itself but it would be wrong to oversimplify and issue definitive value judgments on the role Indians, religious or scientists in South America.

The example of quinine will be chosen to show the breadcrumb trail that connects them. The Indians had realized through experimentation the virtues against fevers (malaria) of cinchona bark, a small tree growing on the eastern slopes of the Andes. The Jesuits, during their missions, recognized its curative power and, by means of their entries into Rome and by the great reputation of the plant, following the care given to the Marquise de Cinchon, the wife of the Viceroy from the Indies of Lima in 1638, they introduced it to Europe and elsewhere in the tropics under the name of "herb of the Jesuits".



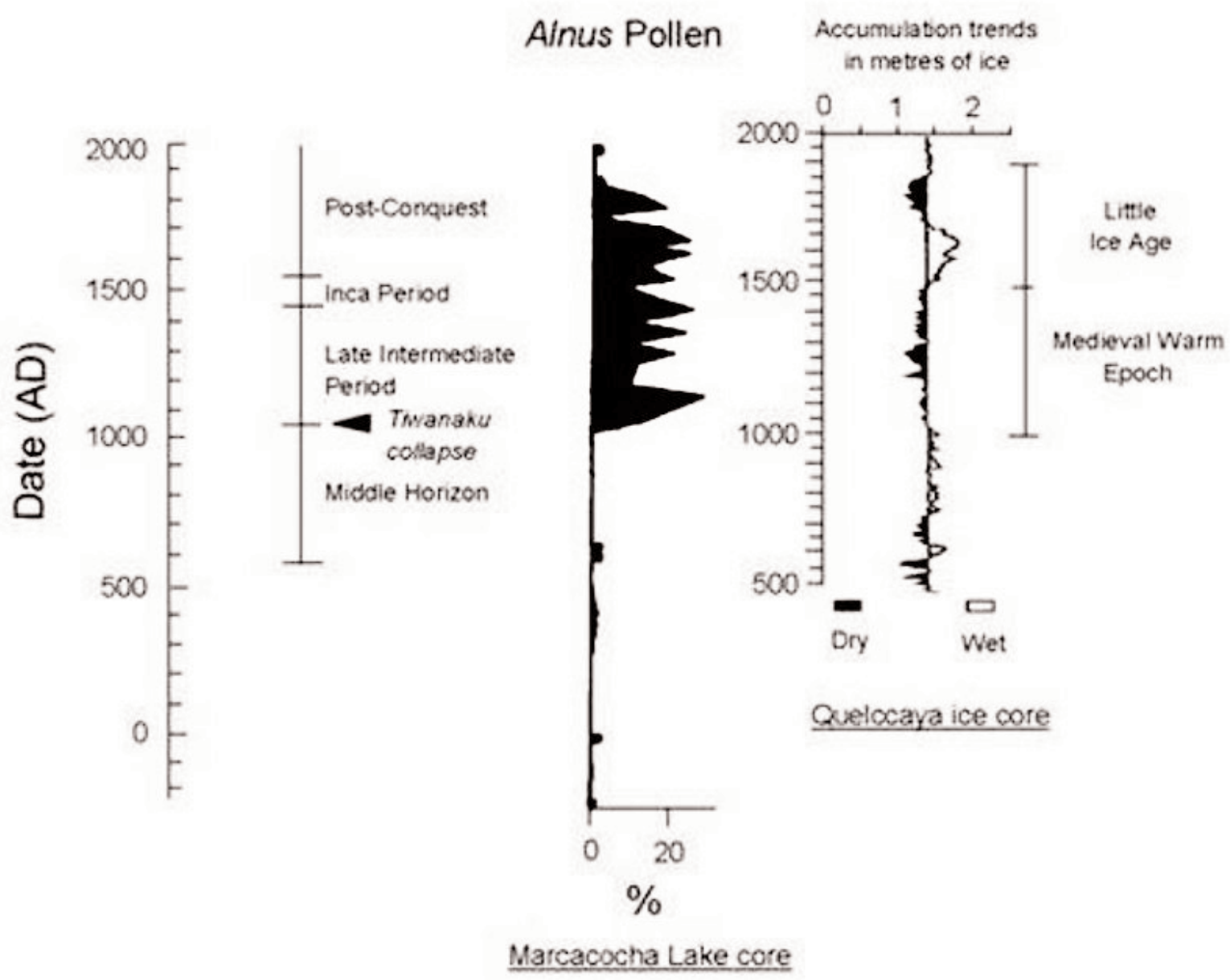
From the 18th century; scientists seized it and quinine allowed the colonization by Western nations of the intertropical zone by drastically improving the health of populations. There was a cinchona boom between 1820 and 1870 in the Andes for harvesting the bark of wild specimens, before it was plundered by Westerners who created homogeneous plantations far from the cinchona woods of Latin America, its cradle. Quinine allowed the European colonization of all low tropical and subtropical zones at the end of the 19th century.

Until 1850 and the start of the industrial revolution, fluctuations in solar activity and volcanic eruptions were the main sources of climate change, but, underlines the North American National Academy of Sciences in a very recent report, these changes "were significantly less pronounced than those

caused by industrial-age pollution since the mid-19th century". Automobile pollution in rapidly growing cities and dust from bush fires and burning (Amazonia and Andean forests) are singled out. The problem of deforestation is posed because clearing is far from being compensated by reforestation.

Large cities close to the Andes or Andes like Santiago and Cochabamba among the most polluted in the Americas.

Finally, to understand climate change, remember that, for example, La Paz, one of the capitals of Bolivia, was a small city of around 40,000 inhabitants at the end of the 19th century. and that it has become, with the new city of El Alto and 120 years later, a megalopolis of 2 million people.



Hence, a new urban climate marked by a continuous increase in temperatures, accentuated by feedback, by dust from automobile exhaust gases and bush fires. Consequently, the German Vuille excludes a priori for this reason the cities of the Andes with strong growth in his statistical analyzes of meteorological data.

The purely global approach does not make it possible to understand the great alternations between glacial and interglacial periods (whose diagram above shows the last 420,000 years). The rhythm of these alternations depends on very small variations in the Earth's

orbit and in the inclination of its axis of rotation, which modify the distribution of solar irradiation with latitude and seasons. But if these so-called Milankovitch variations control the rhythm of the alternations, the amplitude of these climatic changes depends on feedbacks on the one hand from the extent of the ice on the parasol effect, on the other hand from the composition of the atmosphere. (mainly water vapor and CO2) on the greenhouse effect.

Is the weather out of whack?
Alteration of the atmosphere, global reinforcement of the greenhouse effect, regional reinforcements of the parasol effect: all these changes necessarily lead to modifications in the atmospheric circulation, in the distribution of precipitation, in the preferred trajectories of storms. Are the cyclones, storms, floods and other disasters that make the headlines the heralds of global warming? No: the climate is defined by the statistical characteristics of the weather, over a period of 30 years. Variability is one of them.

We will be better able to predict bad weather and protect ourselves, but modern and complex societies are becoming more vulnerable in other respects -- such as electricity distribution networks, transport, telecommunications. Over the next few decades, the climate will change far more than in the 20th century, and this change will not be limited to "global" warming; it is certain that the risks of extreme events (prolonged droughts, very heavy rains, storms, etc.) will change, and this for the worse in certain regions. This will have to be taken into account for the safety of people, for long-life infrastructure, for land use planning, for forest management, for insurance.

Solar activity

As the ultimate source of 99.97% of the energy flows that cross our planet's atmosphere, doesn't our Sun vary? If what is mistakenly called the "solar constant" (the solar irradiance at the average Sun-Earth distance outside the atmosphere), were to increase by only 1.5% (from 1367 to 1389 watts per meter square), this would have as much effect ("radiative forcing" in the specialist jargon) as a doubling of CO2. But here it is: precise measurements from space (it is true that they only exist since the 1970s) only indicate very rapid fluctuations that can reach 0.4% and a variation of amplitude 0.1% depending on the 11-year cycle of solar activity, fluctuations very weak and too rapid to influence the climate. It is conceivable that a sustained increase of 0.3% in solar luminosity between 1850 and 1950 explains part of the warming then. The solar measurements of this period do not have the precision necessary to decide this question, the calculation of the possibilities of solar fluctuations does not have it yet.

For the coming century, a doubling of CO2 seems almost certain, a solar variation of 0.3%, not to mention 1.5%, completely hypothetical. Of course, there is an abundant scientific literature of serious work in many institutes and observatories: statistical correlations between such and such a meteorological or climatic parameter with such and such an index of solar activity. We know that solar activity modulates the physical state of the thermosphere, a few hundred kilometers above sea level. We imagine physical mechanisms that would cause the very real fluctuations of ultraviolet radiation, particle emissions and the solar wind to influence the troposphere (layers at an altitude of less than 10 km) where meteorology and climate are played out.

Influence of solar variability on atmosphere and climate

Although the mechanism by which changes in solar activity influence climate is not yet fully understood, the most likely mechanism involves the absorption of UV radiation by stratospheric ozone which conditions the temperature of the stratosphere. Any change in the solar flux (which occurs for the most part in the UV) causes changes in the temperature gradient between the equator and the poles and therefore changes in the stratospheric circulation. These are transferred to the troposphere and can lead to changes in temperature on the ground: Ts much greater than those which would be due solely to the change in radiative flux. The understanding of this amplification mechanism through dynamics is a subject that is currently evolving rapidly and which could finally answer the question of sun-climate relationships that has been open for many years. In addition to the observed fluctuations in Ts, this would explain the Little Ice Age and its relationship to the Maunder Minimum at the end of the 16th century.

o Stratospheric aerosols

During violent volcanic eruptions, the injection into the stratosphere of large quantities of sulfur dioxide, which is quickly converted into sulphate aerosols, can on the one hand contribute to destroying ozone and on the other hand play a role of screen for the solar flux and thus cool the surface. The washing process by the rains not operating, the lifespan of these aerosols in the stratosphere can reach 5 years. The most recent eruption, that of Mount Pinatubo in 1991, led to a cooling of the surface reaching 0.6°C in the summer of 1992, but this effect is temporary (1 - 2 years).

o Dynamic exchanges between stratosphere and troposphere

The tropopause is far from being an insurmountable barrier between 2 regions of the atmosphere which ignore each other. The exchanges of matter and energy are very frequent, but still poorly quantified: in general, there is transfer from bottom to top at the level of the tropics, lateral transfer at mid-latitude and downward transfer at the level of the poles. . But many transfers take place outside the tropics and the poles, especially when tongues of stratospheric air enter the troposphere, during what are called tropopause foliations. The notion of tropopause (sometimes defined as the altitude of the minimum temperature) is itself currently being reviewed. It would not be a fine well-defined surface, but a layer 1 to 2 km thick. In addition, we are beginning to observe changes in the altitude and temperature of the tropopause as a result of the increase in GHGs. The consequences of such changes on the climate are not yet modeled, but they are likely not negligible.

o Connections between stratosphere and troposphere

The existence of such connections is currently the subject of serious considerations, in particular the propagation of the Arctic Oscillation (AO) towards the troposphere and the surface, and the similarity of its annular structure with that of the North Atlantic Oscillation. The radiosoundings of the last 50 years have made it possible to highlight the existence of two modes of meteorological situation over Europe: hot and humid / cold and dry) depending on the strength of the polar vortex and the temperature in the stratosphere (strong vortex and very low stratospheric temperature / stretched vortex and relatively high temperature). The impact on weather forecasting can obviously benefit from the existence of such connections, and now medium-range forecasting models like the UK Met Office model are using this data to extend their forecasts from 5 to 40 days.

Carbon on our planet From the atmosphere... to the ground

Atmospheric carbon is not an evil in itself: it is what makes our planet livable... but everything is in the quantity: remember that on the planet Mars, which no longer has an atmosphere and therefore no gas greenhouse gas, it is -50° Centigrade on average, and on Venus, which has clearly abused the greenhouse gas, +420°). The temperate nature of our Planet comes from the fact that there are approximately 600 billion tonnes of oil equivalent permanently above our heads; and the disadvantages of global warming come from the extra 165 that we have sent since the beginning of the industrial era; we must therefore find a way to reduce these 165 billion undesirable tonnes. In fact, by far, far away, most of the planet's carbon is stored in the sea or under the sea, in tonnages significantly greater than those of the atmosphere, in fact approximately 50 times more.

The stock of fossil fuels (all aggregated: oil, gas, coal) was worth about 3,700 billion tons of carbon in 1750 - before we started to dip into it. Since then, we have exported a few hundred billion tonnes, so in fact a very small part of the stock! When we predict the end of fossil fuels, it is in fact a stylistic clause because there are still a lot of them, six times more than there are in the atmosphere! And so, we can really destroy the planet if we continue this irresponsible exploitation. For example, we had the impression a few years ago that there was more oil and that we were going to run out of it seriously. It was ignoring our ability to exploit oil shale which, for example, means that the United States of America is now an exporter and no longer an importer of oil and gas. It's basically that carbon that got stored in the atmosphere and caused a lot of problems for us. And, despite all our efforts, which therefore remain totally insufficient, we continue to dump around 6 to 9 billion tonnes each year.

The rest of the carbon is located in continental ecosystems, ie around 2,300 billion tonnes. This is two-thirds of the carbon stored in agricultural land, at a depth of a few meters, and the remaining third in the vegetation that has grown on this land, and of course especially the 3,000 billion trees. Let's remember this order of magnitude: there is currently four times more carbon in and on our soils than in the atmosphere! We see that it is only the 165 billion tons added to the atmosphere that poison our existence, that is to say barely 0.5% of the approximately 45,000 existing on the planet. This shows the very great fragility of the latter, and also sets a roadmap for the future. We should be able to act, therefore we must!
Carbon exchanges between seas and atmosphere are important, can we accelerate the capture process?

The idea would be to significantly increase the storage of carbon in the seas and oceans, since the vast majority of the carbon present on earth is in fact dissolved in the sea. Plankton, corals and fish indeed absorb carbon dioxide and their waste and corpses eventually fall in a continuous "rain", called "sea snow" on the seabed. What is not consumed by the deepest organisms slowly forms sedimentary rocks, which fixes carbon for millions of years in the form of rocks. Given the huge areas involved, it is estimated that this phenomenon fixes about half of the carbon dioxide that is absorbed on the planet. However, this point is still subject to controversy fueled by partial and contradictory studies, some finding that the seas sequester more carbon than previously thought, others demonstrating that in fact they release a lot. In reality, we realize that we know very little about this environment. To begin with, in the current state of technology, we do not really know how to store more carbon there. One of the ideas that have been put forward would consist of spreading microparticles of iron or iron sulphate to boost the sequestration of carbon by the ocean thanks to plankton. Some experiments have been done, in particular in 2002 in Antarctica, which gave hope that for each iron atom spread, between 10 and 100,000 carbon atoms could be fixed. It is therefore feared that the disadvantages of this additional storage are very significant, in particular in the acidification of seawater...

A solution

Plowing has been the most powerful symbol of agriculture for millennia, so much so that farmers have often been referred to as "ploughmen"! But, come to think of it, it is a real heresy in terms of energy balance.

Plowing called into question

Plowing also has many other disadvantages: it destroys the life of the soil which is nevertheless essential to agriculture: bacteria, fungi, earthworms, etc., and it promotes erosion and soil compaction. , water runoff, etc. When you dig a trench in a field you can clearly see what is called the hard "plowing sole" is absent of any biodiversity, on the first 50 centimeters; life begins below, but annuals have a hard time getting there! And even its main raison d'être: to eliminate weeds, is a service that it renders very imperfectly, since the seeds of weeds buried in this way can remain buried for five to seven years with impunity without rotting; what we pushed in year N will therefore inevitably come out and in excellent shape in year N+1!

It is quite obvious that if we activate photosynthesis during the summer instead of leaving the fields bare, we capture a lot more atmospheric carbon, which is then intended to remain in the ground, and therefore we actively contribute to cooling the planet! We see here direct seeding in these cover crops, which turn into fertilizer, after having captured as much nitrogen and atmospheric carbon as possible.

Changing practices for soil conservation agriculture

In fact, by practicing this so-called soil conservation agriculture, we kill two birds with one stone: we maximize the efficiency of photosynthesis by capturing a lot more carbon, and we protect the life of the soil, which makes us feel good by digesting a lot more. effectively the vegetation thus produced to really fix this carbon in the soil; and in the end, a soil loaded with carbon and micro-organisms of all kinds is much more fertile.

In addition, no-till agriculture could in Europe lower the extreme temperatures of heat waves by up to two degrees, thus offering an option to reduce the effects of global warming. No-till allows residues to remain on the land after harvest, which reflect much more solar radiation, thus reducing the amount of heat absorbed. An example is provided by permanent grasslands: they accumulate enormous quantities of organic matter, essentially in the form of roots and micro-organisms, in a relatively stable manner over long periods of time, since they are not plowed or fertilizer application. But around the world, since 1850, much of this grassland has been converted to fields or urbanized, thereby losing large amounts of carbon through oxidation. The quantities captured depend on the type of species being cultivated; among grasses, it seems that red fescue is one of the most effective, but in this respect, the secret is the mixture of complementary species: a good pasture often has several dozen of them, between grasses and legumes.

For a sustainable and adapted transition

With these new agricultural techniques, we can therefore engage in a real virtuous circle, and pursue three goals at the same time: feed humanity, improve soil fertility and biodiversity, and cool the planet!

Note however that this virtuous technique needs to be continued over a long period, because in fact the storage of carbon in the soil is temporary and reversible; any abandonment of this practice leads to the opposite movement of carbon mineralization and destocking... If we set up public support systems for this activity, they must therefore be sustainable!

All in all, it is therefore through a combination of multiple techniques that agriculture can begin to store carbon again: planting forests and hedgerows of course, but more generally agroforestry, permanent soil cover, direct seeding, natural grassland, grassing of orchards and vineyards, etc. And let's underline that this technique absolutely does not prevent us from producing food for our contemporaries!

The climate and the ozone layer

When talking about changes in the global environment, reference is frequently made in the media and in the public to two environmental problems which are sometimes treated in a completely separate way, but frequently confused as if they were one and the same problem: it is on the one hand stratospheric ozone and the famous "ozone hole" and on the other hand the increase in greenhouse gases (GHG) and resulting climate change.

These are two very different issues. As a first approximation, we can deal with the problem of climate change without including the stratosphere and the fate of the ozone, ignoring climate change. However, the problems are not totally independent; there are many interactions between them.

Remember that the stratosphere is the first place where a change in the environment of indisputable anthropic origin has been demonstrated. While the reality of climate change (i.e. the temperature on the surface of the earth) was still in doubt in 1995 (second IPCC report), it was 10 years earlier, in 1984, that stratospheric ozone was found to have halved over Antarctica at the start of the austral spring.

The total thickness of the ozone layer, which conditions ultraviolet penetration, varies according to latitude and season, but its average value during the last 70 years when many measurements are available, has been remarkably stable and this until the years 70-80.

These concerns arose particularly in relation to the development of the supersonic Concorde aircraft which was to create significant amounts of nitrogen oxides in the stratosphere. But in fact the most dangerous compounds for ozone turned out to be halogenated organic compounds, including chlorofluorocarbons (CFCs) which are synthetic molecules very chemically stable and therefore without direct danger to living beings. It is for this reason that they were developed and used in many applications: refrigerants (refrigeration, air conditioners), propellant gas in aerosol cans, synthetic foams, solvents...and have thus played a very beneficial role in improving our way of life. Because of their great stability, these gases remain in the atmosphere for decades (50 to 100 years), and they are gradually transported into the stratosphere, where, under the influence of solar ultraviolet radiation, they are dissociated and release chlorine which then has the ability to enter cycles of catalytic chemical reactions leading to the destruction of ozone.

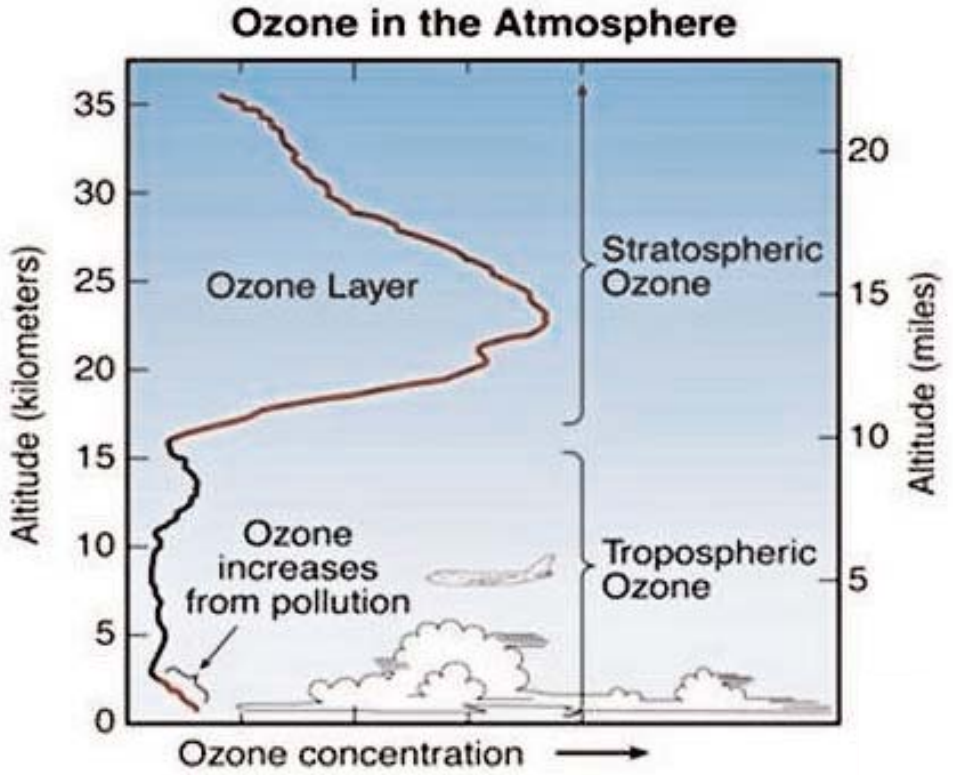


Figure 1: The greatest amount of ozone (90%) is located in the stratosphere in what is called "the ozone layer" between 15 and 40 km. The increase in ozone in the troposphere is due to pollution from human activities. © Public domain

The destruction involves two chemical reactions, one transforms the chlorine oxide ClO into the chlorine atom Cl which subsequently destroys the ozone, but restoring the oxide ClO, which allows the cycle to start over a large number of time. Chlorine thus acts as a

catalyst and a very small quantity of ClO can destroy a large number of ozone molecules, provided it is in the presence of atomic oxygen, which is the case thanks to the decomposition of ozone by solar ultraviolet.

Beyond the small decreases in the thickness of the ozone layer that had been predicted and observed since the end of the 1970s in mid-latitude regions, the appearance of the "ozone hole" above the continent Antarctica in 1985 was the first spectacular manifestation of the effect of human activities on the global physicochemical balances of the atmosphere. In this region, almost all of the ozone between 15 and 20 km is destroyed each year in the spring and the total thickness of ozone is then reduced by half. A decrease in ozone also occurs, but with a lesser amplitude, in the spring over the Arctic.

The difference in behavior between the two polar regions comes from a difference in the atmospheric circulation which is more regular above the Antarctic continent, and this circulation maintains in the Antarctic polar stratosphere a very cold temperature favorable to a strong destruction of the ozone. The stability of the cold masses above Antarctica is responsible for this asymmetry between the two hemispheres.

Many were surprised that the "ozone hole" appeared above a continent unpolluted by human activities, while CFCs and other halogenated compounds are mainly emitted in the northern hemisphere. But, after their emission and when they reach the stratosphere, they are subject to large-scale atmospheric circulation. After one or two years in the troposphere, they are distributed at all latitudes, even very far from the regions where they are emitted, and in particular above Antarctica, where colder temperatures are more favorable to the destruction of the ozone layer than in any other region of the globe.

The causes of this destruction were quickly identified. But since

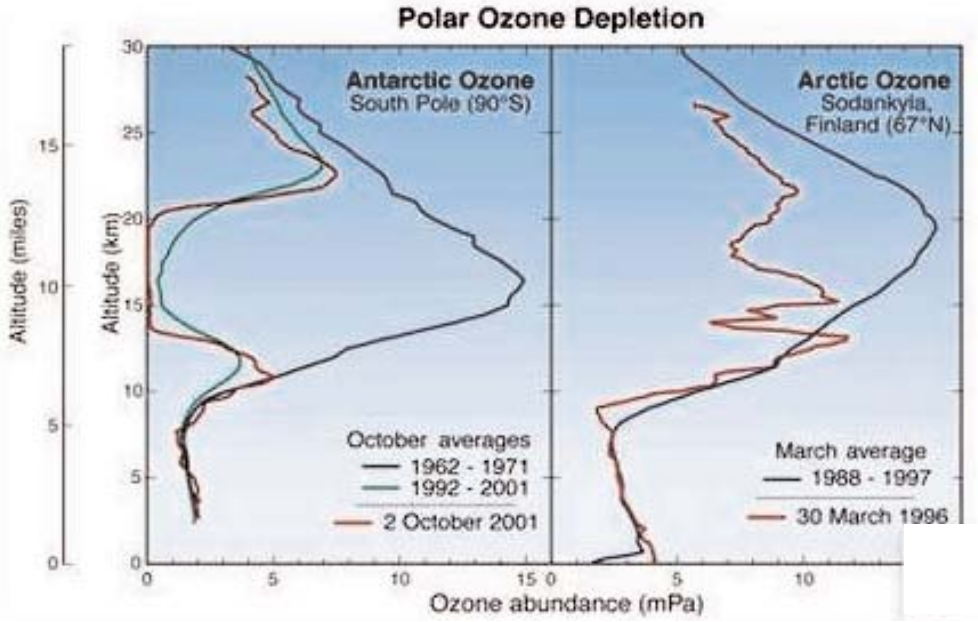


Figure 2: Comparison of ozone profiles obtained recently with average profiles obtained before the action of CFCs . We observe in these examples that the ozone is almost completely destroyed between 14 and 20 km above the Antarctic, whereas the destruction observed above the Arctic is only partial. © Public domain

1987, scientists have discovered other substances in the atmosphere that are just as harmful as chlorine, if not more so. These include bromine-containing compounds, such as methyl bromide used for growing fruit. Bromine is in fact an agent 60 times more effective than chlorine in catalytic ozone destruction processes. The ban on the use of methyl bromide soon followed this awareness and we are beginning to see the effects on the amount of bromine present in the stratosphere.

In 1987, the Montreal Protocol was implemented, a protocol which, amended several times to reinforce its impact, has now led to the beginning of the restoration of the ozone layer. This constitutes the first example where the application of an international protocol applied to the environment has proven its worth, and such an example is precious when the international community is today confronted with a problem, certainly one of great difficulty. higher, that of the implementation of the Kyoto Protocol to limit greenhouse gas (GHG) emissions.

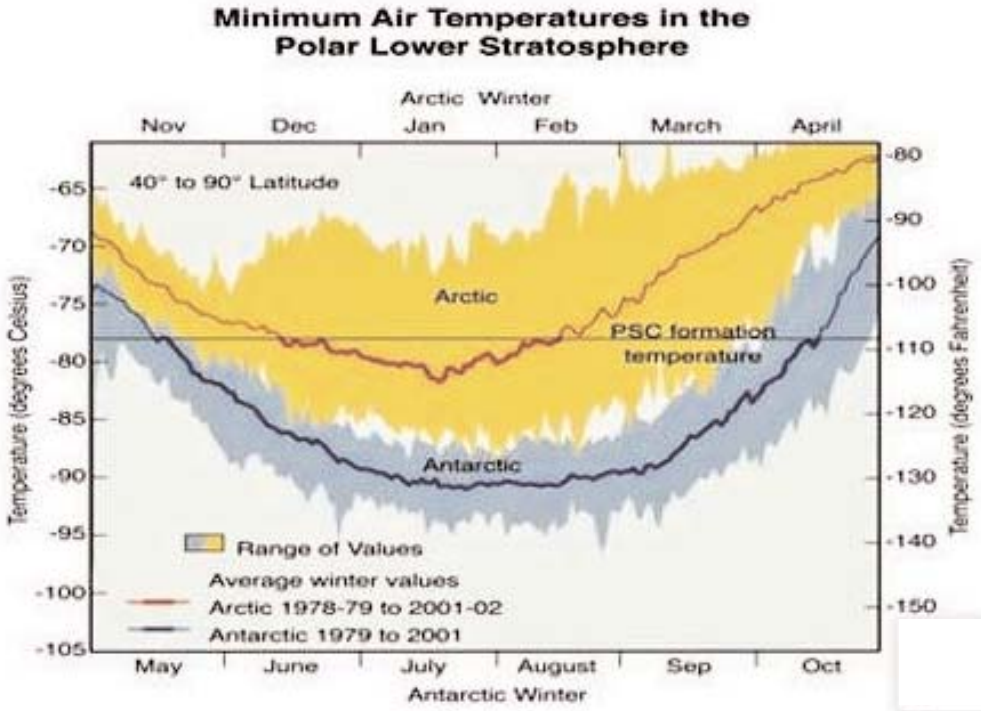


Figure 3: Arctic and Antarctic temperature variation during winter. © Public domain

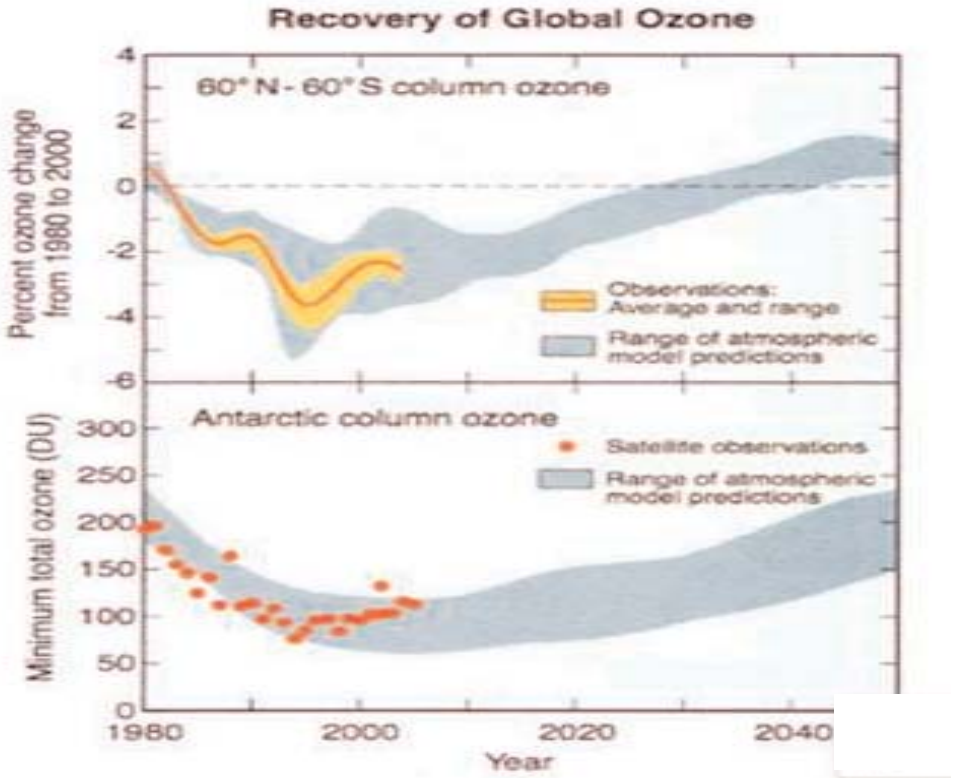


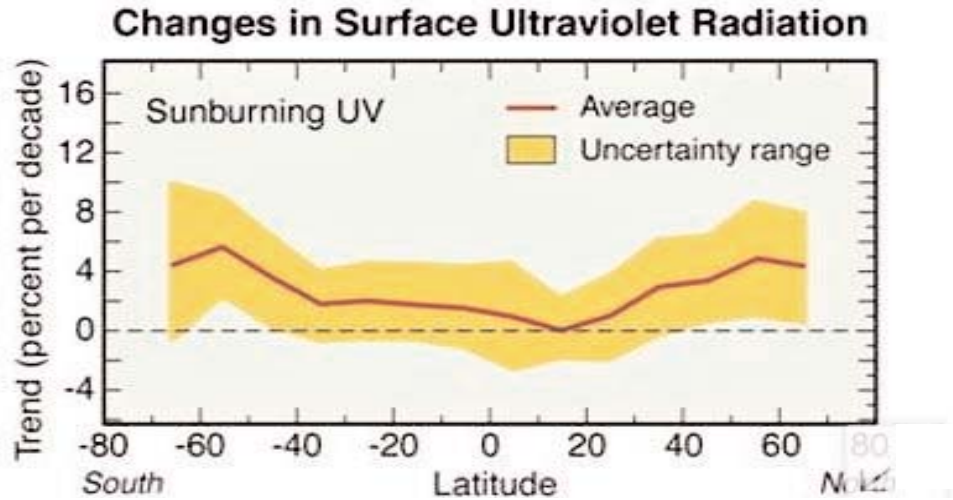
Figure 4 : Forecast of recovery of the ozone layer: values observed between 1980 and 2005 and forecast according to the models. The upper panel corresponds to mid-latitudes, the lower panel to Antarctica. We see that the ozone values preceding its destruction by CFCs will not be found until the middle of the century. © Public domain

If this reduction in the thickness of the ozone layer, at the poles as well as at mid-latitudes, had been amplified, the whole world would have been subjected to the same effects. Such an increase in ultraviolet radiation would have presented major risks for the whole planet, both for humans and animals (skin cancers, cataracts, etc.), for forests and crops (reduced photosynthesis and lower yields).

Relationship between climate change and the ozone problem

These two subjects are very frequently confused, whereas, as has just been shown, the decrease in stratospheric ozone is a problem quite distinct from that of climate change. On a planetary scale, the problem of maintaining the stratospheric ozone layer that surrounds the Earth is an excellent example of a global environmental problem.

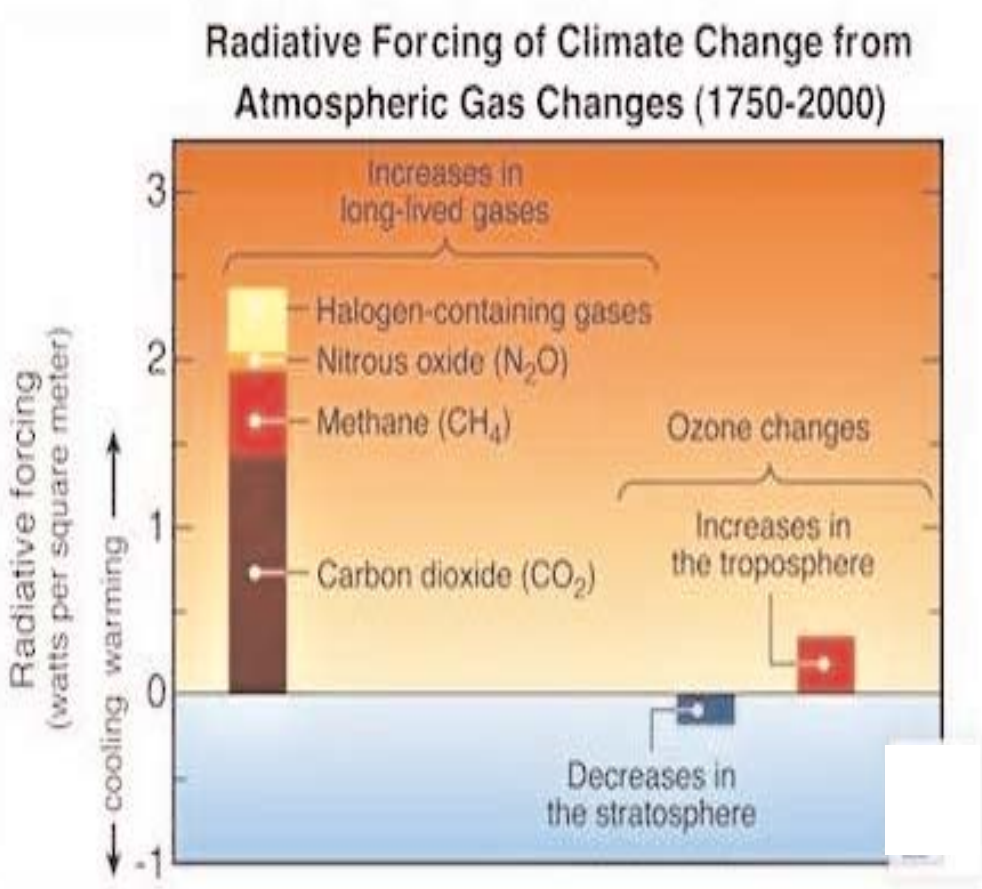
They differ both in their causes and in their consequences. Indeed,



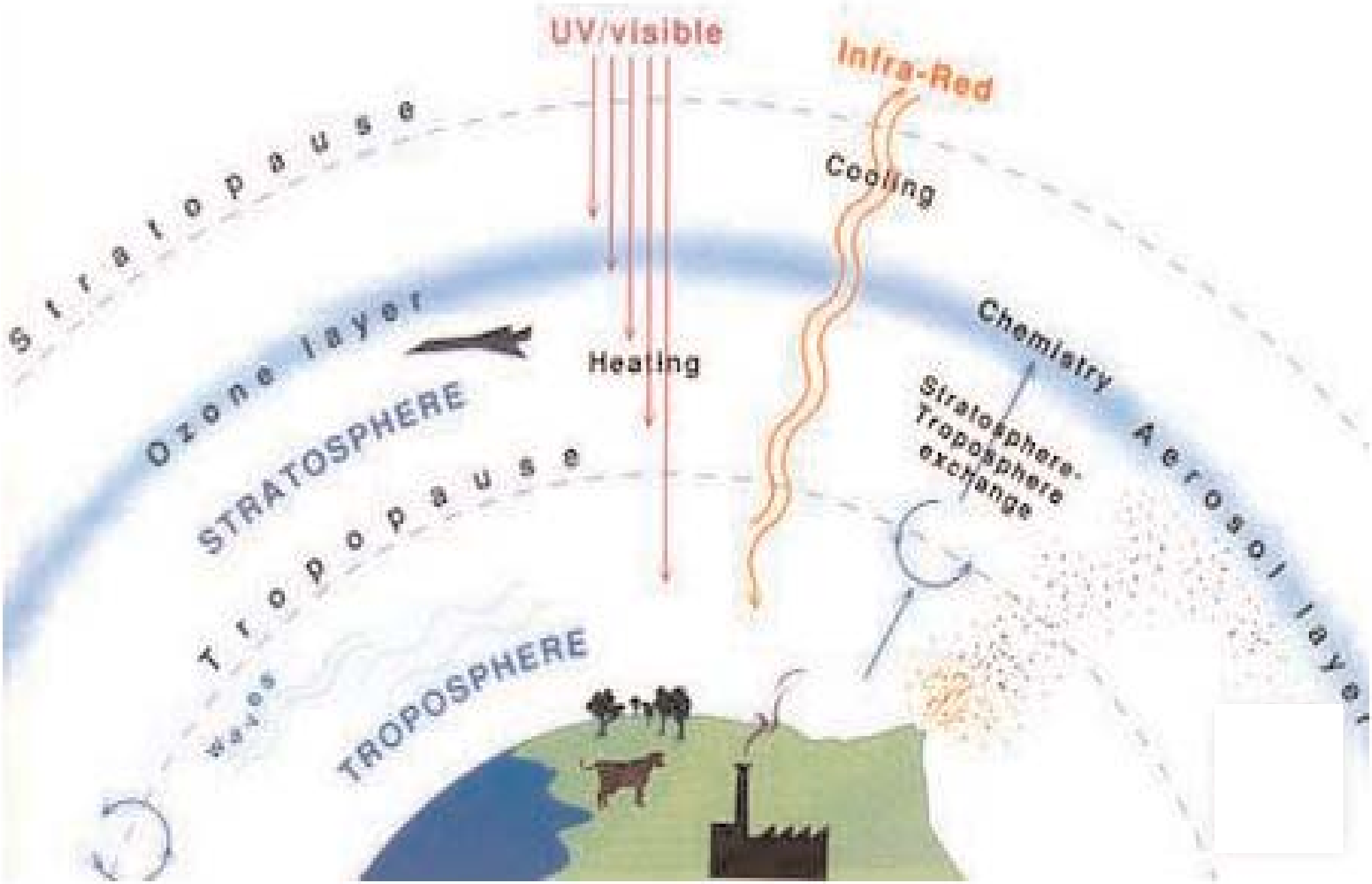
Change in UV-B ultraviolet radiation at the surface between 1979 and 1992. ©

climate change is the consequence of the increase in greenhouse gases, while the decrease in ozone comes from the presence in the stratosphere of chlorinated, brominated and nitrated species which are not a priori gases. Greenhouse effect. The consequences of the first relate to the change in surface temperature, the precipitation regime and the occurrence of extreme events. The consequence of the second is first of all the increase in the solar ultraviolet flux at ground level. It therefore seems difficult to confuse the two problems. However, the complexity of atmospheric interactions is such that mutual influences are inevitable between the two phenomena.

Let's look first at the direct impacts of changes in the stratosphere on the climate. On the one hand, ozone is a GHG. Its decrease leads to a decrease in the radiative forcing of the atmosphere due to the decrease in UV absorption in an ozone-depleted atmosphere in the stratosphere. This effect is maximum if the change in concentration is near the tropopause. The decrease in stratospheric ozone since the beginning of the industrial era thus represents a decrease of around 5% in radiative forcing due to the increase in other GHGs. In the opposite direction, the return to the previous situation of stratospheric ozone will correspond to an increase in radiative forcing. On the other hand, CFCs and most of the substitutes developed to replace them are powerful greenhouse gases. Overall they are responsible for about 13% of the additional greenhouse effect due to all greenhouse gases since the beginning of the 20th century Controlling their production is therefore essential for monitoring climate change and therefore falls within the context of the Climate Convention. Some fluctuations in ground temperature, which are superimposed on the continued growth due to GHGs, are of natural, solar and volcanic origin, and are transmitted and/or amplified by the stratosphere.



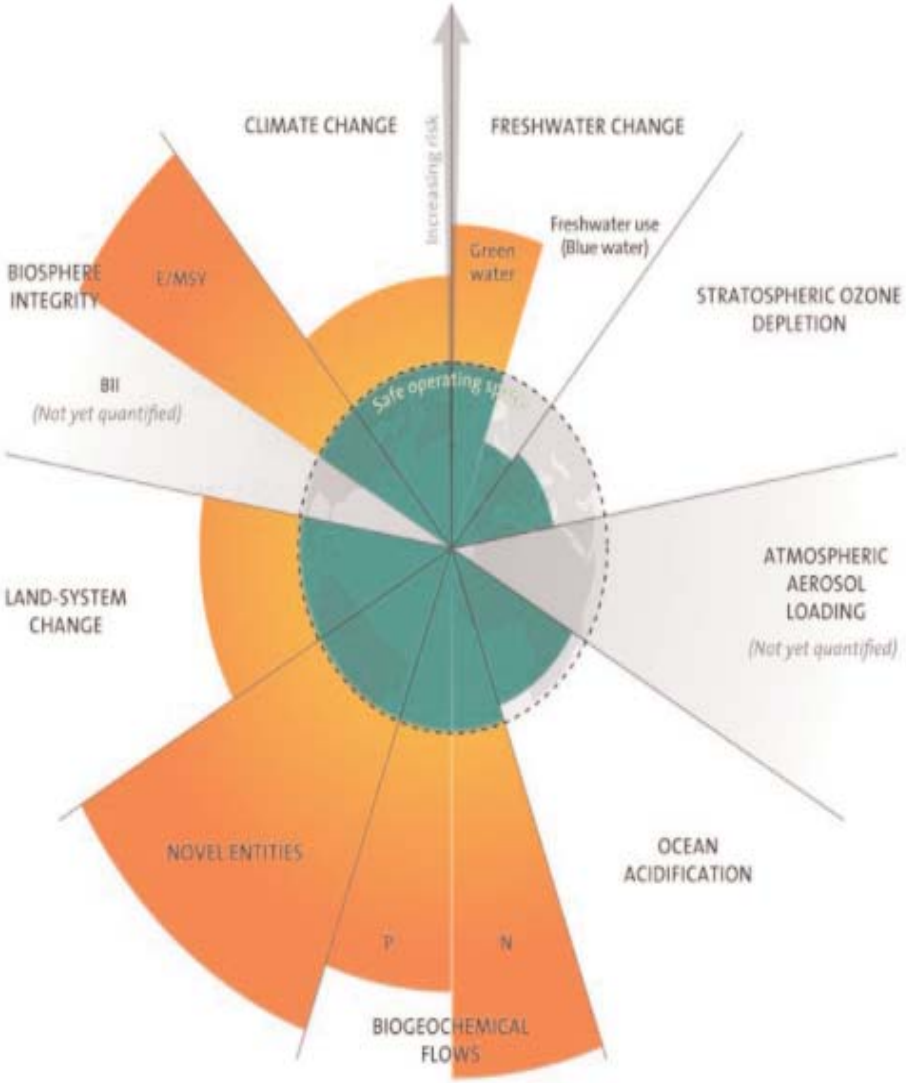
Responsibility of the various greenhouse gases in climate change/: We see in this figure that Halogen gases, both those that play a role in the destruction of ozone and the substitutes put in place to obey regulations, represent approximately 13% of greenhouse gases, the most important of which is carbon dioxide CO2. © Public domain



The different processes affecting the troposphere-stratosphere system: greenhouse gas emissions, volcanic eruptions, ultraviolet and visible solar flux and dynamic exchanges through the tropopause. © Public domain

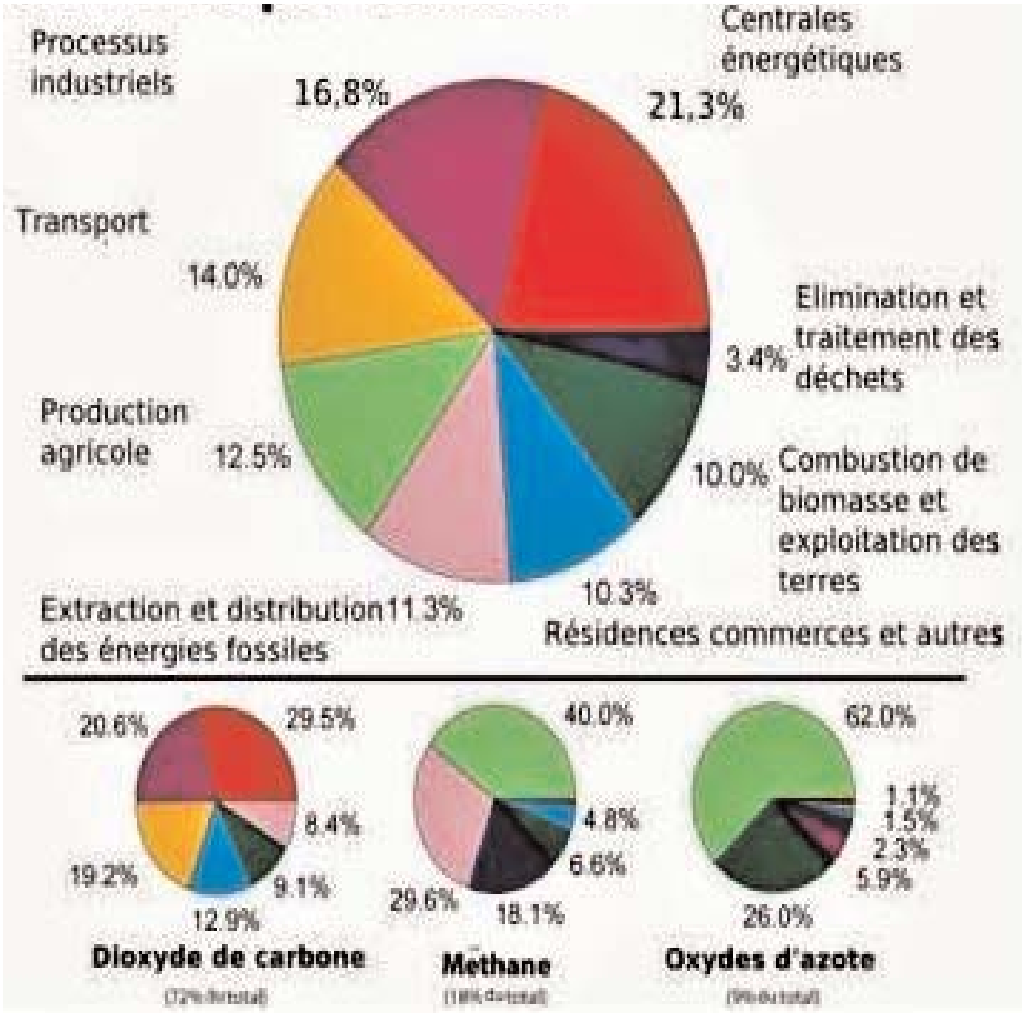
ENERGY AND CLIMATE

There is a close link between energy consumption and climate. This link is due to the greenhouse effect, which we hear a lot about. But let's not forget that there is a natural greenhouse effect. The planet is heated by the Sun; it reaches a state of equilibrium between heat absorbed and heat emitted. Without an atmosphere, the Earth's average temperature would be -18°C.

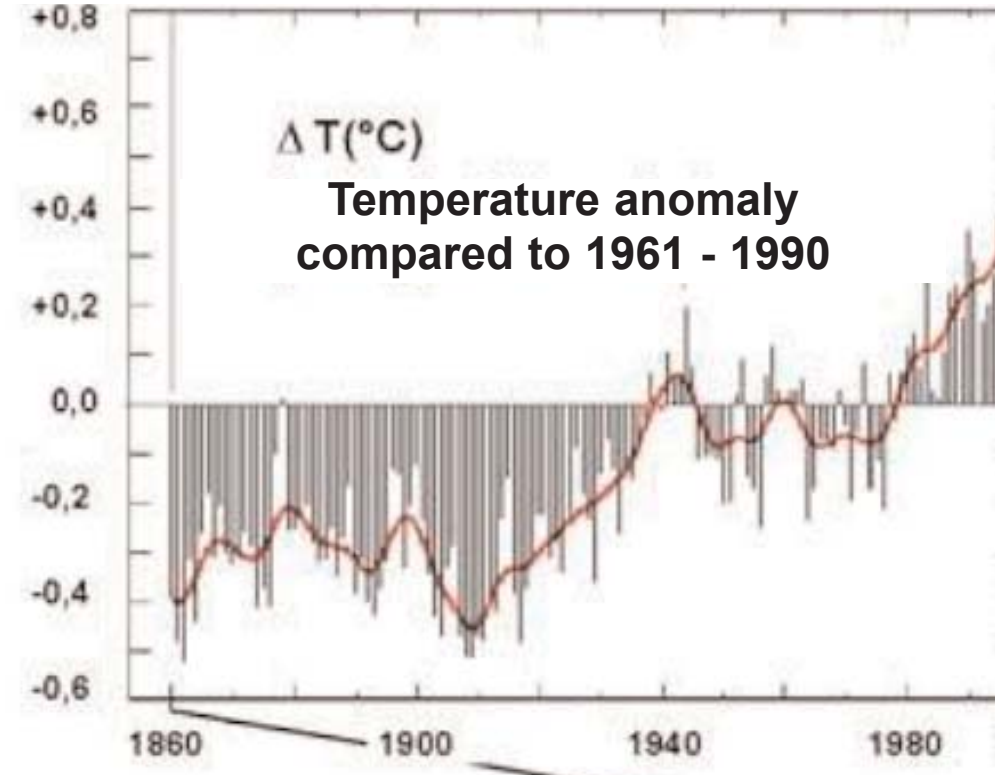


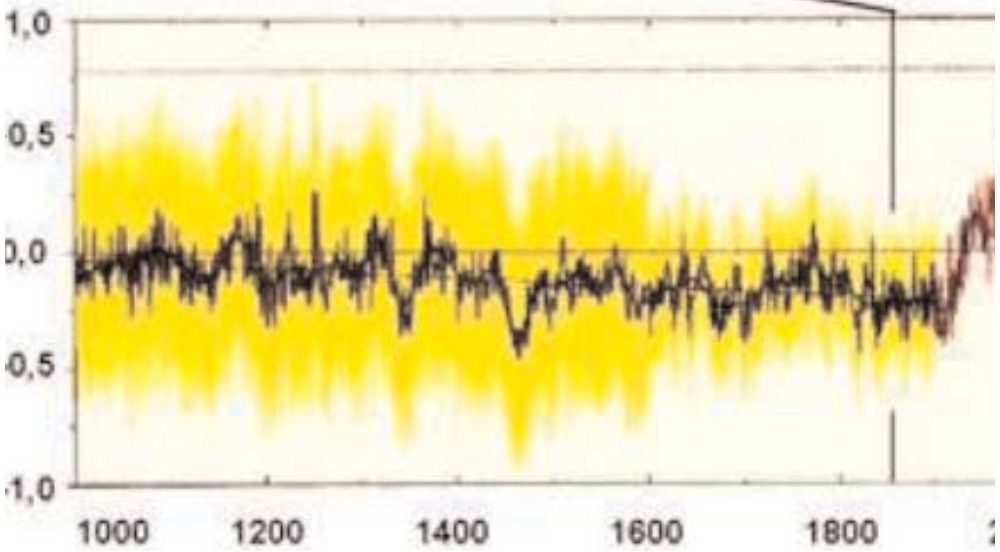
Certain molecules in the atmosphere (water, carbon dioxide, methane, etc.) absorb part of the radiation re-emitted by the Earth, bringing its real average temperature to 15°C. The situation is therefore comparable to that of a greenhouse which lets in sunlight and which retains the thermal radiation coming from the interior, hence the name greenhouse effect. Today, this effect is amplified by human activity due to the emission of additional greenhouse gases into the atmosphere. The main source is carbon dioxide (CO2) although other gases also play a role.

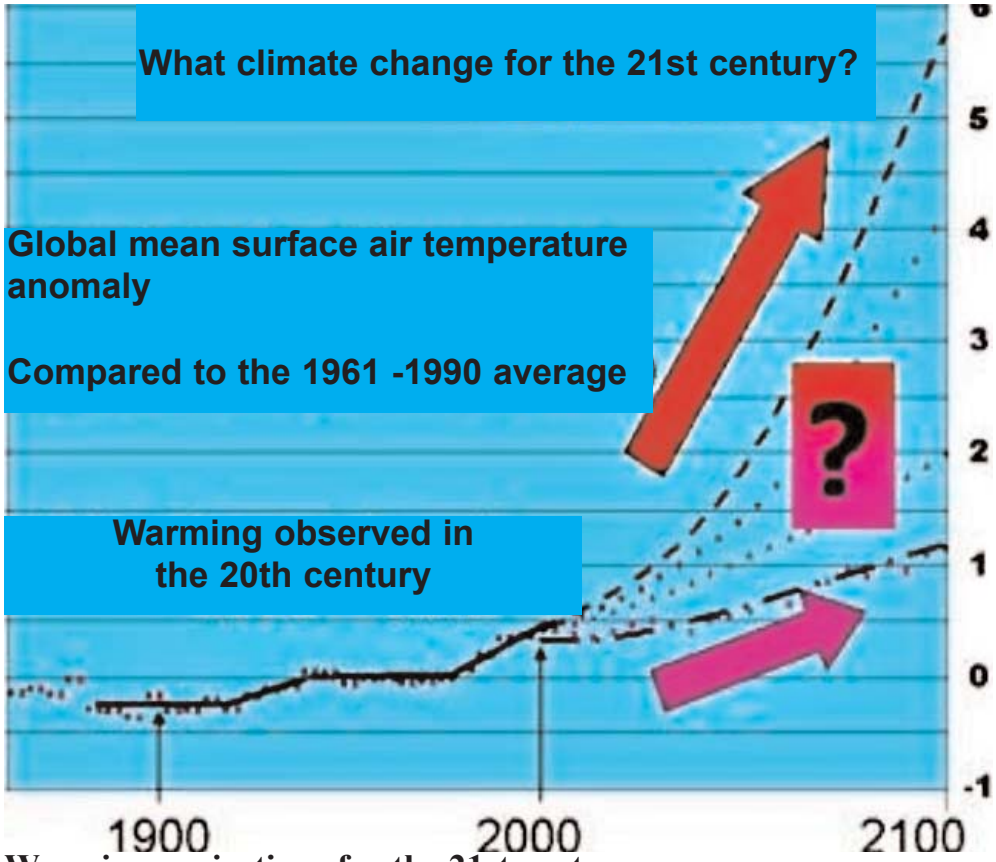
Annual greenhouse gas emissions by sector



The warming observed since 1860 and the reconstruction of the warming since the year 1000. The graphs show the deviation of average air temperatures at the surface of the globe, compared to the climatological average for the period 1961-1990.







Warming projections for the 21st century.

The increase in CO2 levels is partly explained by deforestation, but above all by the combustion of fossil fuels. Measurements made in Antarctica on ice cores show that the CO2 concentration has not been seen for at least 650,000 years.

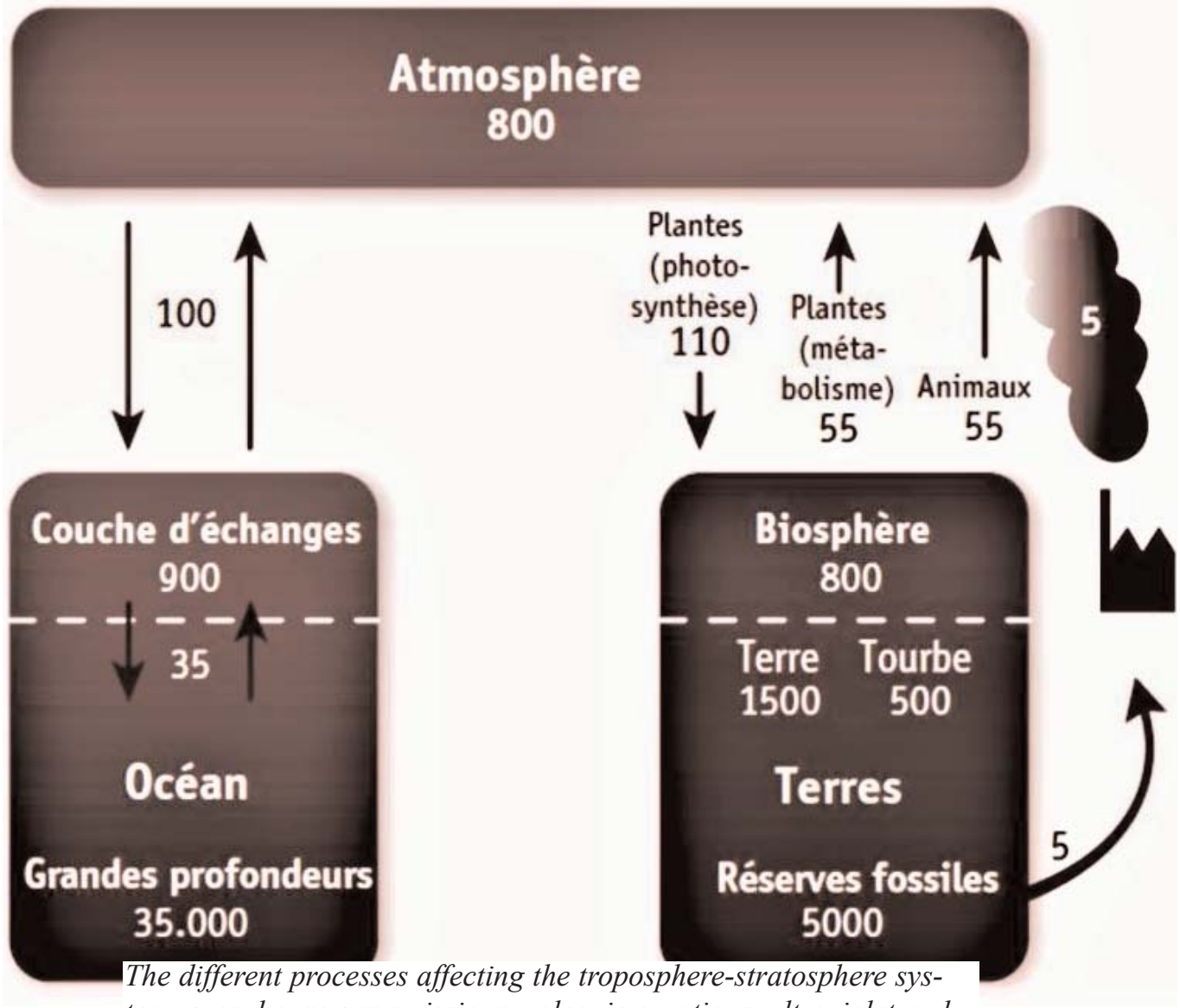
The concentration of CO2 in the atmosphere reached a level in May 50% higher than in the pre-industrial era, unheard of on Earth for around four million years, an American agency alerted on Friday. Carbon dioxide is reaching levels that our species has never seen in the past, which is not a recent phenomenon. We've known that for half a century and we've failed to do anything meaningful. What will it take to wake us up?

Greenhouse effect and climatological consequences

The consequences are only suppositions... but the spectacular increase in the rate of CO2 will inevitably have repercussions. What will actually happen is hard to predict. There is, however, a reasonable level of consensus within the scientific community, as evidenced by the results of the Intergovernmental Panel on Climate Change (IPCC). First, global average temperatures are expected to rise by two to four degrees (or even more) over the coming century, with large geographic disparities. These differences could have an effect on the position of the different climatic zones. Sea levels could rise as a result of melting ice and expanding ocean water.

Among the remedies considered: reducing CO2 emissions by reducing the use of fossil fuels. But we can also prevent the CO2 emitted from ending up in the atmosphere. Planting trees is a good idea, but it won't be enough. Sequestration methods are developing, such as carbon capture and storage. Once captured, CO2 gas can be compressed and transported in pipelines. It is then necessary to find reservoirs of carbon to store it. Oceanic storage is the most attractive solution, given the size of the reservoir that the oceans constitute. The downside is that ocean waters would become more acidic, with as yet unknown consequences for marine life.

It is estimated that 4.2 million people die each year worldwide due to air pollution. Fine particles, with a diameter less than or equal to 2.5 microns (PM2.5), are a frequent source of air pollution. These particles are about 1/30th the width of a human hair and are made up of dust, residue, smoke and heavy metals. Their tiny size makes them particularly dangerous, as they can insinuate themselves into the respiratory tract and cause lung cancer, strokes, diseases.



The different processes affecting the troposphere-stratosphere system: greenhouse gas emissions, volcanic eruptions, ultraviolet and visible solar flux and dynamic exchanges through the tropopause. ©

No more doubt about the anthropogenic cause

The influence of human beings on climate change is clearly established. Accelerating warming, intensifying impacts causing unprecedented suffering to humanity responsible for this devastation, and only one way to avoid the worst, drastically reduce greenhouse gas emissions.

No offense to climate skeptics, scientific evidence has removed any doubts that may remain: humans are "unquestionably" responsible for the warming of the Planet which has gained approximately +1.1°C since the pre-industrial era. .

The beginning of suffering for half of humanity
The devastating consequences of climate change, long seen as a dash on the horizon, have become a reality around the world, with 3.3 to 3.6 billion people already "very vulnerable", or nearly half of humanity. And that's just the beginning. Drought, heat waves with, in places, extreme temperatures that are literally unbearable, storms, floods, water shortages, loss of agricultural crops... The secondary effects of the warming of the atmosphere and the oceans are set to intensify, with a disproportionate impact on the most fragile, such as the poor and indigenous peoples. Without forgetting the possible exodus of hundreds of millions of people faced with the inexorable rise in sea level mainly linked to the melting of the ice caps of Greenland and Antarctica. Even if warming is limited to +2°C, the oceans could gain around 50 cm in the 21st century and this increase could reach almost 2 meters by 2300 - twice as much as estimated by the IPCC in 2019.

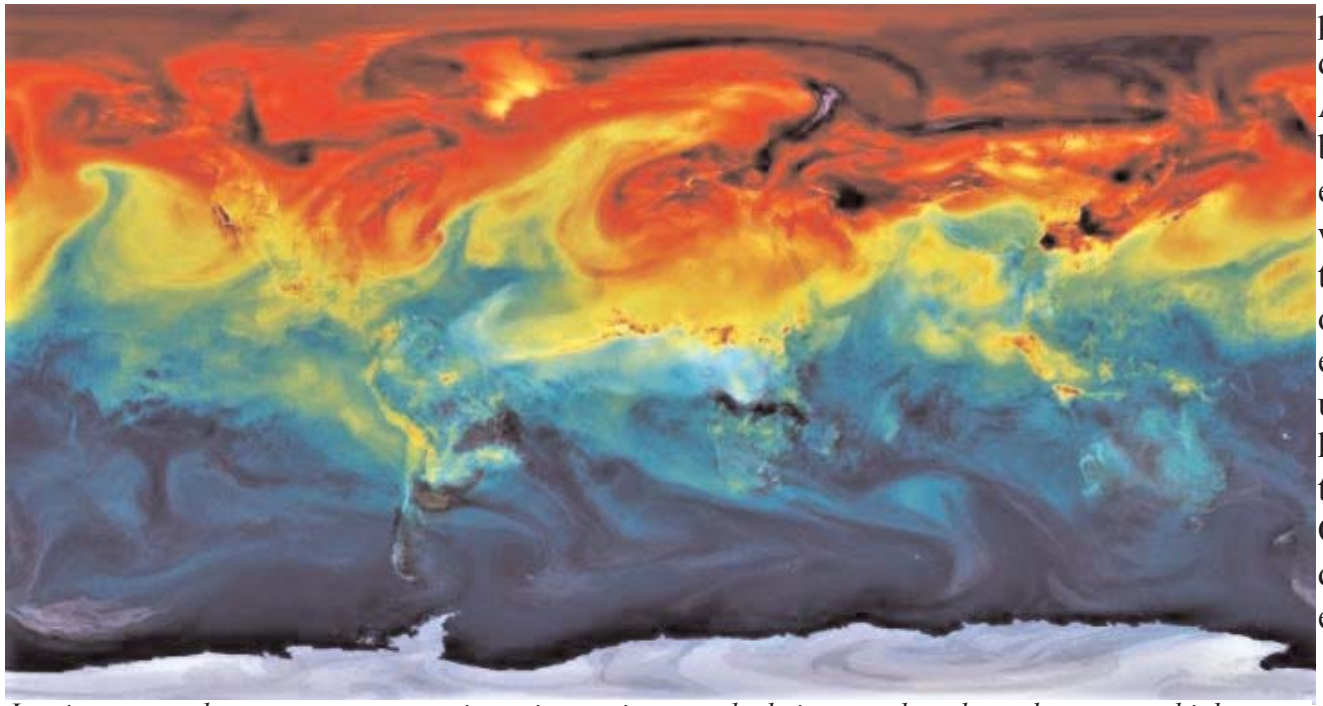
In the Arctic, much more than elsewhere, temperatures are rising. Gradually pushing the forests north. Until threatening the tundra. If coherent measures to combat global warming are not taken now, this unique biome will disappear by the middle of this millennium. Because the local flora and fauna populations are very vulnerable to disturbing influences. And one thing is clear: if we carry on as if nothing has happened, this ecosystem will gradually disappear.

To limit global warming to +1.5°C would thus require a major transformation of the energy system, with the reduction in the use (without carbon capture technique) of coal, oil and gas respectively by around 100 %, 60% and 70% by 2050 compared to 2019.

The point of no return leading to the total collapse of the ice caps, capable of raising the sea by tens of meters; the thawing of permafrost which contains immense volumes of carbon; or even the transformation into savannah of the Amazon which absorbs a vital part of the CO2 emitted by human activities.

The rate of increase in the concentration of CO2 in the atmosphere between 1900 and 2019, largely linked to fossil fuels, is at least ten times higher than during any other period of the last 800,000 years and the concentration of CO2 in the atmosphere has never been so high for more than 4 million years.

It is important to understand to what extent vegetation plays an absolutely fundamental role in regulating the climate on our planet. NASA's Goddard Research Center has produced images that beautifully illustrate this phenomenon, showing the concentration of carbon dioxide in the atmosphere day after day in different regions of the globe (the more carbon dioxide, the more color turns yellow and red).



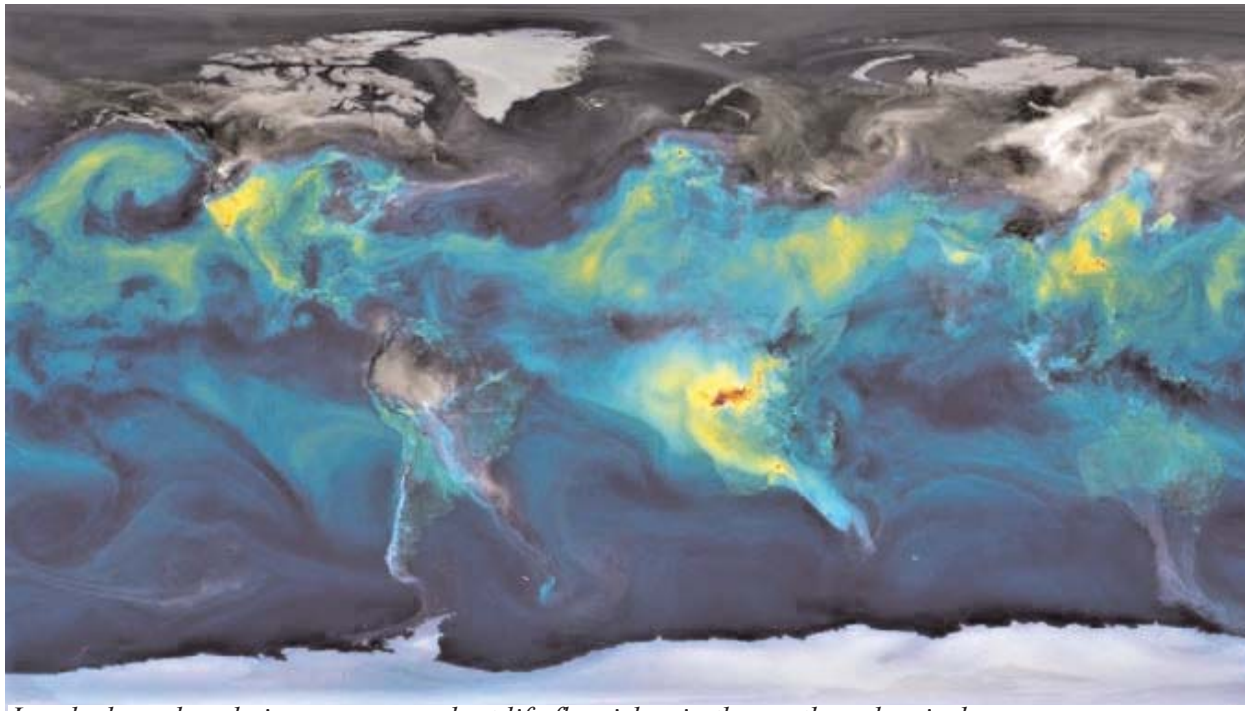
In winter, greenhouse gas concentrations rise again towards their annual peak, each year at a higher level than the year before. © Nasa

Different concentrations of greenhouse gases depending on the season.

If we start at the beginning of January, we can observe in a very graphic way the effects of industrialization in North America, in Europe and especially in China: the emissions are massive, and these deleterious gases are spreading throughout the northern hemisphere depending on prevailing winds.

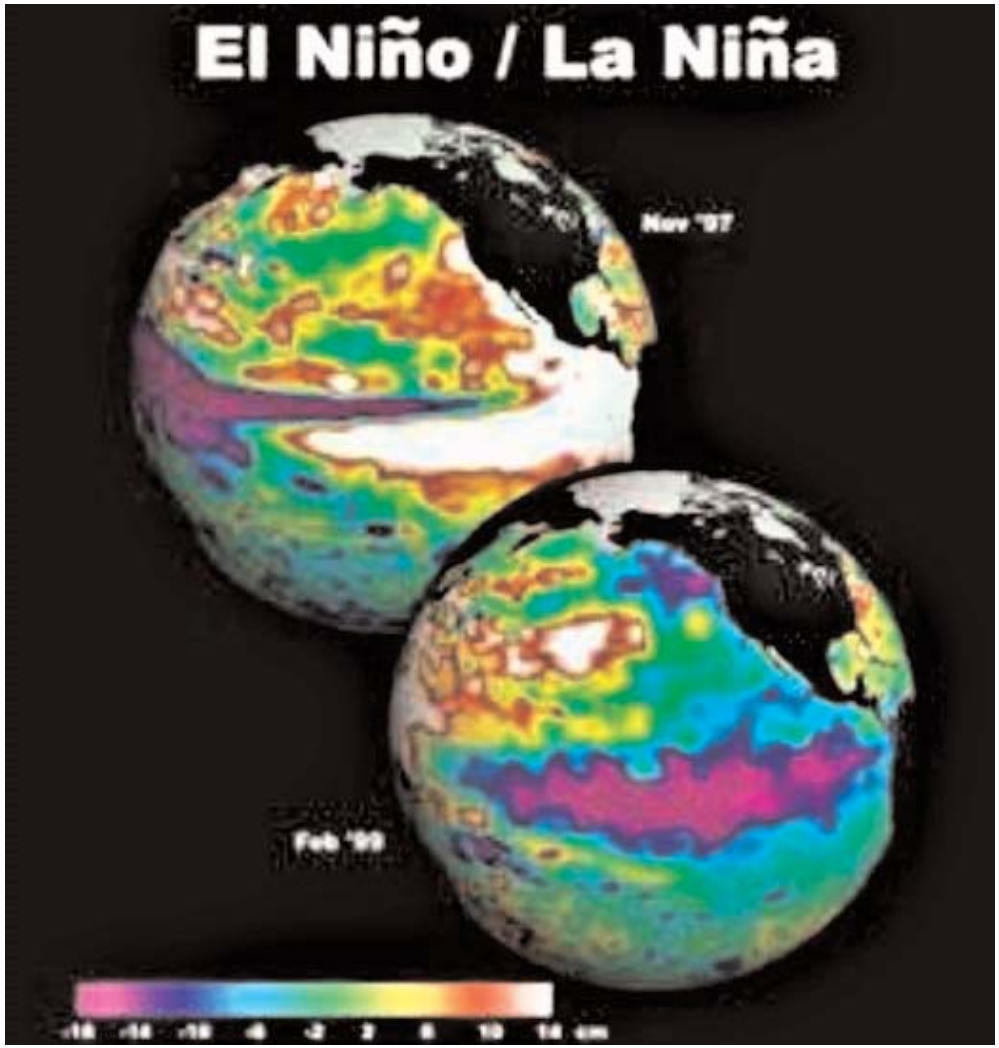
They accumulate and, when we arrive at the beginning of spring, they reach a maximum: the planet is extremely polluted and therefore global warming is at its maximum.

And then, from the month of June, miraculously, the vegetation develops in the northern hemisphere and begins to seriously capture carbon from the atmosphere, which causes the concentration of carbon dioxide to decrease relatively rapidly. Admittedly, the factories continued to pollute, but Nature was at that time the strongest. At the end of the summer, in August and September, we returned to more or less acceptable rates: thank you plants, thank you trees, humanity can once again breathe a little better, despite the forest fires that continue assiduously! And then unfortunately, nature goes to rest in the northern hemisphere, the factories redeploy their efforts, the population starts to heat up again, and from October and November the situation becomes dramatic again... and , like every year, our planet literally suffocates at Christmas!



Levels drop sharply in summer as plant life flourishes in the northern hemisphere.

The climatic phenomenon El Niño - La Niña



We risk witnessing a "super El Niño" during 2023/2024, a warming of the waters of the Pacific which, for its part, would have the capacity to significantly aggravate the current global warming. If this were confirmed, because it is only a hypothesis, the global rise in temperatures could be increased tenfold with particularly serious effects for several regions of the world.

In order to anticipate these occasional jolts in the course of the seasons and to help better planning of savings, scientists are seeking to understand these rival rhythms, the most marked of which is called El Niño and presents an alternation between a "normal" climate and a set of "different" (but recurring) climatic conditions in the Pacific. The term El Niño (meaning "Baby Jesus" in Spanish) was originally used by fishermen along the coasts of Ecuador and Peru and applied to a warm ocean current that usually appears at the time of Christmas, only to disappear a few months later. Fish are then less abundant during these warm intervals, and anglers often take the opportunity to repair their fishing gear and stay with their families. In some years, however, the water is particularly warm, and the fishing season is suspended until May or sometimes June. Over time, the use of the term "El Niño" has been reserved for those exceptionally warm and marked intervals, which not only disrupt the lives of these South American fishermen, but also bring intense rains.

Over the past 40 years, 9 El Niños have affected the South American coast. The tenth is in progress... Most of them have coincided with an increase in sea water temperature not only along the coast but also in the Galápagos Islands, and over a belt that extends about 8000 km to across the equatorial Pacific. The least marked events correspond to a temperature increase of about 1°C and a minor impact on South American fisheries. But the most violent ones, like that of 1982-1983, not only left their mark on local marine life and climate, but also on climatic conditions on a planetary scale.

The 1982-1983 event

The 1982-83 El Niño, which is often considered the most intense of this century, was not predicted or even recognized by scientists during the early stages of its development. In retrospect its origins can be detected in May 1982 when the surface easterly winds (trade winds) that usually extend from the Galapagos Islands to Indonesia began to decrease. West of the International Date Line, the winds reversed, associated with the onset of a period of stormy weather.

Over the next few weeks, the ocean began to react to changes in wind speed and direction. Sea levels in the Christmas Islands in the central Pacific rose by nearly 10 cm. In October, the sea level was abnormally high by nearly 25 cm over nearly 6000 km from the Equator. As it rose in the eastern Pacific, it simultaneously subsided in the western Pacific, exposing (and destroying) the upper layers of the fragile coral reefs that surround many islands. Surface temperatures in the Galapagos Islands and along the Ecuadorian coast had risen from 22°C to over 27°C!

In response to these changes in the Pacific Ocean, marine flora and fauna reacted quickly (Figure 1).

After sea level rises in the Christmas Islands, seabirds abandoned their offspring and scattered across the ocean in a desperate search for food. During the return to normal in mid 83, 25% of adult seals and sea lions and all newborns had died. Many species of fish met a similar fate. Along the coasts stretching from Chile to British Columbia sea temperatures were above normal, and fish that usually live in tropical or subtropical waters had migrated towards the poles. On the other hand, some species have benefited from these unusual conditions, as evidenced by the unexpected harvests of scallops on the Ecuadorian coast.

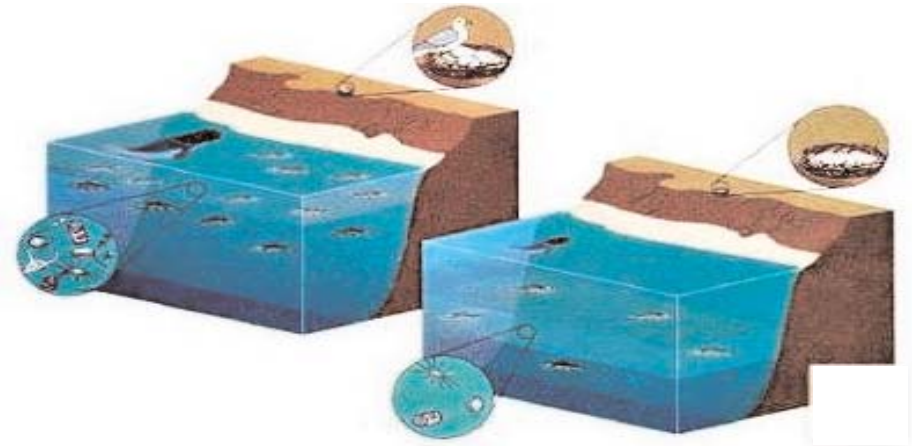


Figure 1 These figures show the stark contrast that exists for the marine ecosystem along the coasts of Peru and Ecuador between a normal year (left) and an El Niño year (right). The warm, nutrient-poor water brought in by an El Niño can only support a small amount of phytoplankton (small creatures that are at the base of the marine food chain). Fish, sea lions and other sea animals must dive deeper into the ocean to search for food. Seabirds scatter over the oceans, abandoning their young.

The El Niño of 1982-1983 also had dramatic effects on the continents. In Ecuador and northern Peru about 250 cm of rain fell for 6 months, transforming the coastal desert into grassland, with the appearance of 6 lakes. The appearance of new vegetation led to the arrival of swarms of grasshoppers, allowing the expansion of bird colonies. The new lakes also provided temporary habitat for fish that had come upriver from the sea during the floods, and were now trapped there. Many of them were caught by local residents when these lakes dried up. In some flooded estuaries, shrimp production has reached record levels, as has the number of cases of malaria (induced by the resurgence of mosquitoes).

As these examples show, the economic impacts of this El Niño were widespread. Along the South American coast, losses exceeded profits. The fishing industries of Ecuador and Peru suffered terribly when their anchovy catches vanished and sardines fled to (colder) Chilean waters. Further west, the wind anomalies diverted the typhoons from their usual routes, towards Hawaii or Tahiti unprepared for such weather conditions. These anomalies also shifted the monsoon rains to the central Pacific, instead of the western Pacific. Droughts and forest fires then broke out in Indonesia and Australia. Thunderstorms battered southern California in the winter, causing flooding across the southern United States, while northern ski resorts complained of a season that was too cold and hot. an obvious lack of snow. The total cost for the planet of this El Niño has been estimated at more than 100 billion francs. The psychological impacts, or even the number of victims, are more difficult to assess.

The link between these globally scattered climatic effects and El Niño is now well established. Yet it took time for scientists to figure out how the different pieces of the puzzle fit together, from ocean currents to intense winds and rain. Several years ago, the British scientist Sir Gilbert Walker actually laid down the first elements of the reflection.

During the 1920s, while scientists in South America were busy documenting the local effects of El Niño, Walker was stationed in India, trying to find useful ways to predict the Asian monsoon. By studying the atmospheric data at his disposal, he noticed a remarkable correlation between the barometric readings of the eastern and western Pacific. He realized that the pressure increased in the west when it subsided in the east, and vice versa. He used the expression "Southern Oscillation" to characterize this seesaw movement visible in barometric data.

During the high index phases of this oscillating movement, the pressure is high in the eastern Pacific and low in the west. Along the equator, the zonal (longitudinal) pressure contrast accelerates the surface winds from east to west, from the Galápagos Islands to Indonesia. During the low index phases, the pressure difference between the two ends of the basin decreases, and the surface trade winds subside. It is in the western Pacific that the most marked wind changes occur. West of the International Date Line the trade winds disappear while they are just attenuated to the east - (Figure 2). Walker realized that monsoon seasons associated with a low index were often characterized by droughts in Australia, Indonesia, India and various parts of Africa. He also stated that these low indices were also associated with particularly mild winters in Western Canada. A colleague of his attacked him in a scientific journal for daring to suggest that climatic conditions in such distant regions of the globe could be linked. in his answer Walker predicted, correctly, that an explanation must exist but that it must presumably require knowledge of the structures of the wind at levels other than the ground (which at the time was hardly observable).

Over the ensuing decades, researchers added new pieces to this Southern Oscillation puzzle. Such information came from a remote region of the world about which Walker had little information: the

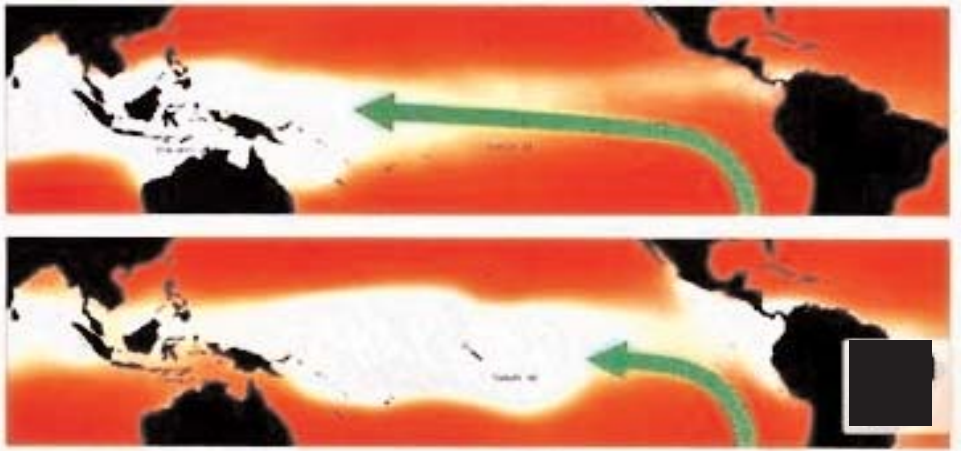


Figure 2 Sir Gilbert Walker provided an important insight into the understanding of El Niño when he discovered that sea level pressures in the South Pacific oscillated between two distinct states. During an upper phase of what Walker called the "Southern Oscillation" (above, for November 1988), pressure is higher (dark red) near and east of Tahiti than further west of Tahiti. Darwin. this pressure gradient along the equator pulls air westward (long arrow). When the atmosphere switches to a low index phase (low, for November 1982), the barometers are up in the west and down in the east, signaling a reduction, or even an inversion, of the pressure difference between Darwin and Tahiti. The flattening of this pressure structure causes the surface trade winds to weaken and retreat to the east. We know that this low index phase is usually accompanied by El Niño conditions.

desert islands of the central equatorial Pacific. According to normal climate statistics, these barren islands receive as much rain as many other islands which instead feature lush vegetation. The origin of this paradox becomes trivial when one examines the statistics for these islands year by year: most often the precipitation is in fact very low, even nil, but on the occasion of certain "low index" years

it is veritable deluges that descend on it day after day, month after month. Thus Walker's pressure index is found to be linked to dramatic changes in the distribution of precipitation in the tropics.

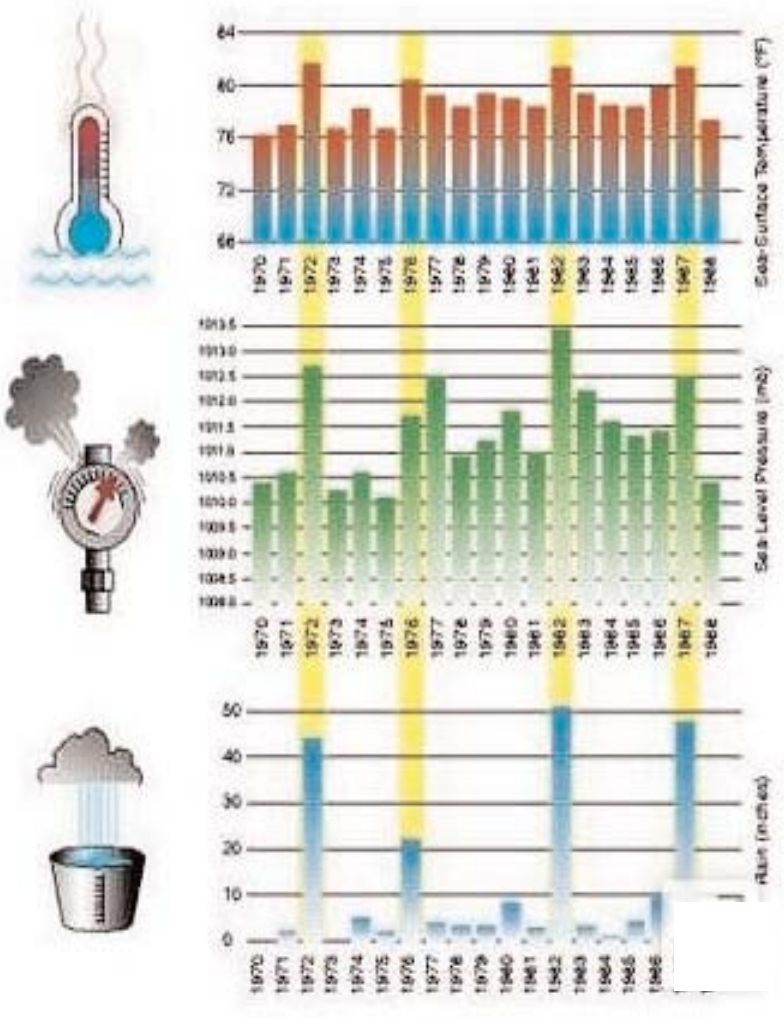
Towards the end of the 1960s, Professor Jacob Bjerknes put in place an important new piece of the puzzle. In fact, as a young researcher, Bjerknes had established his fame by publishing the first comprehensive description of the mid-latitude storm life cycle. Nearly 50 years later, he was the first to see a connection between abnormally warm surface temperatures, weak trade winds and heavy rainfall that accompany low index conditions. It was therefore Bjerknes who first established that El Niño and the Southern Oscillation were two parts of the same phenomenon, often referred to as ENSO.

In order to protect themselves from the possibility of such surprises (i.e. the arrival of a "dissident" El Niño), the scientists continued to document as many past events as possible, by arranging together small bits historical evidence from a wide variety of sources - (Figure 3)

Other indirect evidence, based on coral samples, provides insight into how the frequency of past El Niños varied over centuries to millennia. Data from the oldest trees (variable spacing between two consecutive growth rings) also provides information on past events.%0.

To understand how El Niño affects the ocean, one must first learn how surface winds move ocean water in normal years and how the induced movements affect temperatures and chemical nutrient contents, available to the base of the food chain. We will consider two distinct regions: the equatorial Pacific that extends west from the Galápagos Islands to the International Date Line, and the coastal waters along Peru from southern Ecuador.

The trade winds that blow along the equator and the southeasterly winds that blow along the South American coasts all tend to drag surface waters along their path (Figure 5). Due to the rotation of the Earth, the currents are deflected to their right in the northern hemi-



El Nino years highlighted in yellow

sphere, and to their left in the southern hemisphere. Surface waters are thus pushed towards the poles at the equator, and offshore along the South American coast. Where surface water is flushed out, it is replaced by deeper, colder, nutrient-rich water (upwelling). The equatorial upwelling and the coastal upwelling are both concentrated in very narrow regions (of the order of 150 km), and are easily visible by satellite.

Winds blowing along the equator also affect the properties of upwelled water (Figure 6). In the absence of wind, the boundary layer between the warm surface water and the deep cold water (the thermocline) would be, so to speak, flat on the scale of the equatorial Pacific. When the trade winds carry the surface waters towards the west, the thermocline tilts leveling the surface in the eastern Pacific, and sinking in the west.

The cold water below the thermocline is rich in nutrients. When the thermocline is close enough to the surface, the mixing induced by the winds is able to mix them with the surface water. In the presence of light (sunlight), tiny plant species (phytoplankton) use these nutrients to produce a greenish plant substance, chlorophyll.
Phytoplankton bloom is very fast, explosive, and within a week all available nutrients are used. Then the phytoplankton dies and sinks. these blooms are observable by satellite (green spots on the surface of the ocean) during the lifetime of these phytoplankton blooms. These spots can serve as markers of where upwelling phenomena bring nutrients to the surface.

The newly upwelled water is colder than its surroundings. It can be followed for several days by infrared imagery which reveals the temperature of the sea surface (Figure 7). This signature takes the form of a cold tongue that extends westward along the equator from the South American coast.
Thus, the winds control the upwelling, which itself controls the production of phytoplankton. This production in turn affects the evolutions of the tiny marine animals that form the zooplankton, which graze on it, and ultimately the effect is felt at all levels of the marine

Figure 5 Intense southeast winds (red arrow) prevail along the coast of Ecuador and Peru. These winds, which occur during normal years and El Niño years, pull surface water to the northwest, causing cold, nutrient-rich (dark blue) waters to rise to the surface along the coast of East Pacific.

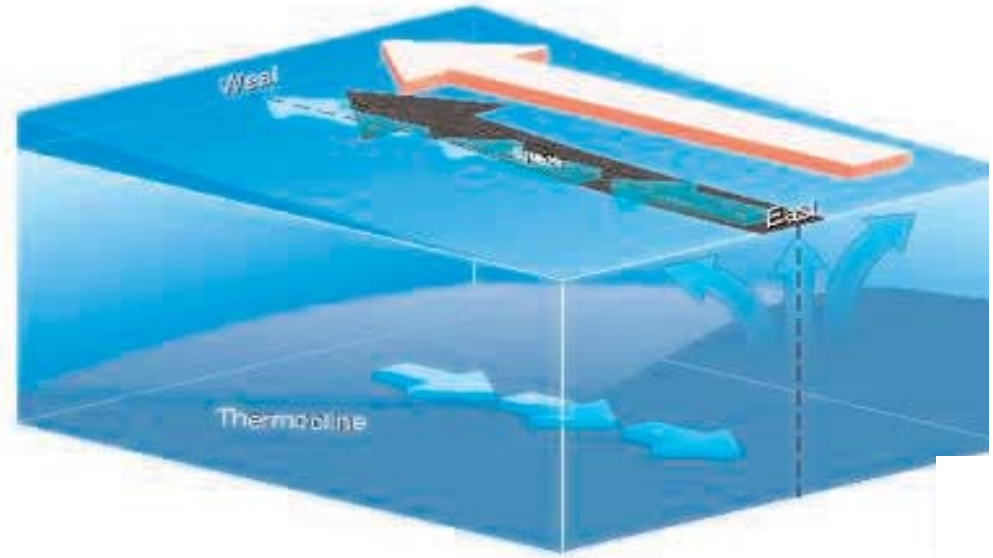


Figure 6 East winds (red arrow) drive surface water westward along the equator. Earth's rotation bends this current northward in the northern hemisphere and southward in the southern hemisphere, pushing water away from the equator and replacing it with water from deeper layers (downward arrows). high). In addition, the winds cause the accumulation of water in the western part of the Pacific. Because the warmer water is less dense, the sea level is higher in the western part of the basin than in the eastern part, where the winds are blowing at full force. The thermocline that marks the boundary between warm surface waters and deeper cold waters (dark blue) is tilted. It outcrops the surface in the eastern equatorial Pacific.

food pyramid. The winds are also responsible for the appearance of the cold tongue in the horizontal structure of the sea surface temperature.

During El Niño years, when the trade winds are confined to the eastern Pacific, the ocean responds in the following way (Figure 8):
* The thermocline flattens along the equator, rising in the west and plunging in the east by several dozen meters.
* The subsidence in the east is strong enough that the coastal upwelling is no longer able to suck up the cold, nutrient-rich water below.
* The equatorial upwelling decreases, further reducing the supply of nutrients for the food chain.
* The cold water tongue retracts or disappears (Figure 9).
* Sea level is flattening, rising in the east and sinking in the west.

Surface water surges to the east of the basin.
When this influx of relatively warm water reaches the eastern part

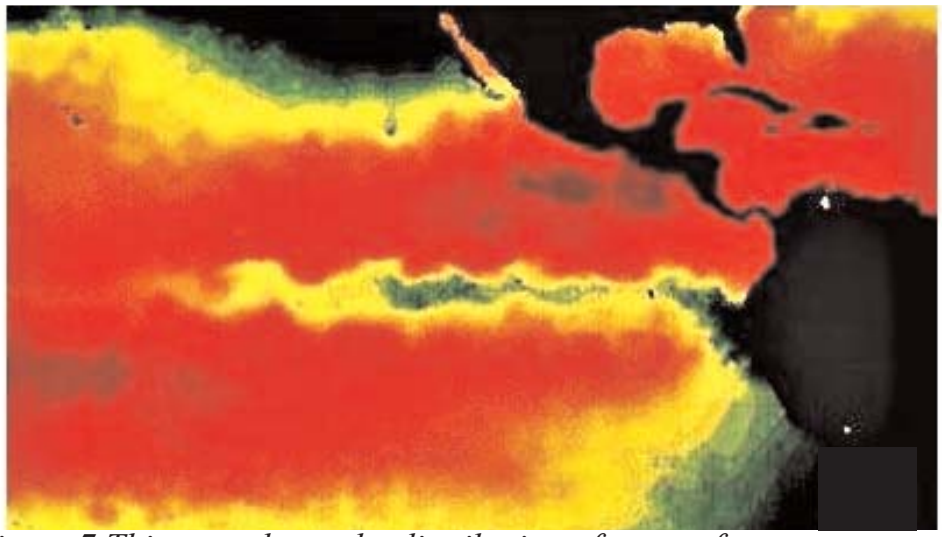


Figure 7 This map shows the distribution of sea surface temperature on May 31, 1988, when the equatorial Pacific was cold. The warmest waters are indicated in dark red, and the colder waters in yellow then green. Note the recently upwelled tongue of cold water extending along the equator from the South American coast.

of the basin a few months later, the presence of the continent forces it to expand south and north along the coast. Sardines and other fish species are leaving this area, and the sea level is rising. These effects could be felt as far north as Canada and south in the middle of Chile.

When the trade winds blow at their full force, the upwelling of cold water along the equatorial Pacific chills the air above it, making it too dense to rise high enough to allow water vapor to condense and form clouds and raindrops. Thus the air remains clear of clouds dur-

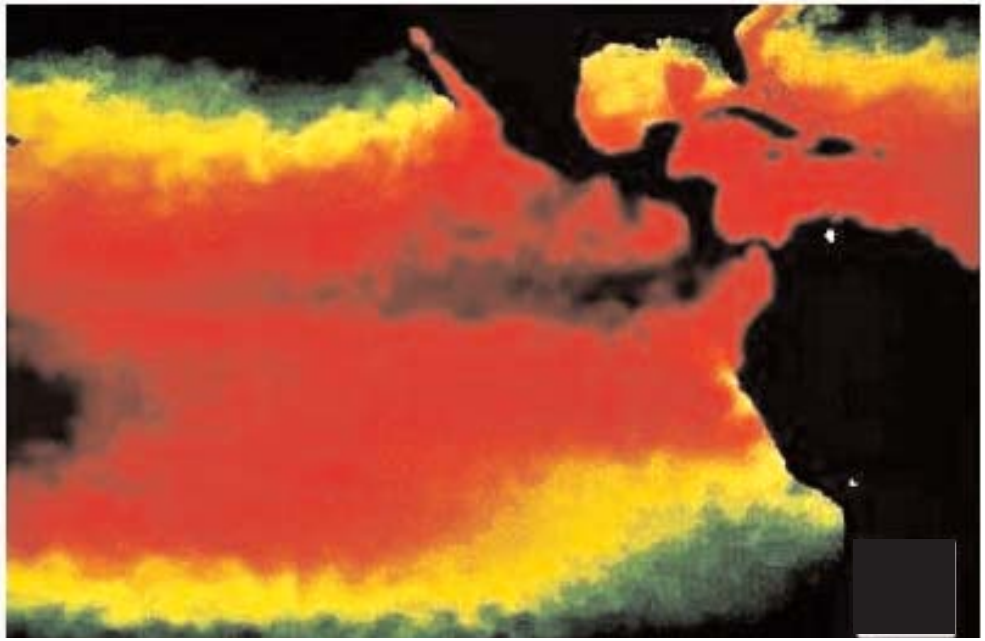


Figure 8 Sea surface temperature appears very different on May 13, 1992, for El Niño conditions, when the thermocline in the eastern Pacific was deeper than normal and when the equatorial upwelling was suppressed. One can note the absence of a well-defined cold tongue.

ing "normal" years, and the rain in the equatorial belt is largely confined to the extreme west of the basin, in the vicinity of Indonesia (Figure 10).

But when the trade winds weaken and recede eastward during the early stages of an El Niño event, the upwelling slows and the ocean warms. Moist air at the surface of the ocean is also warming. It

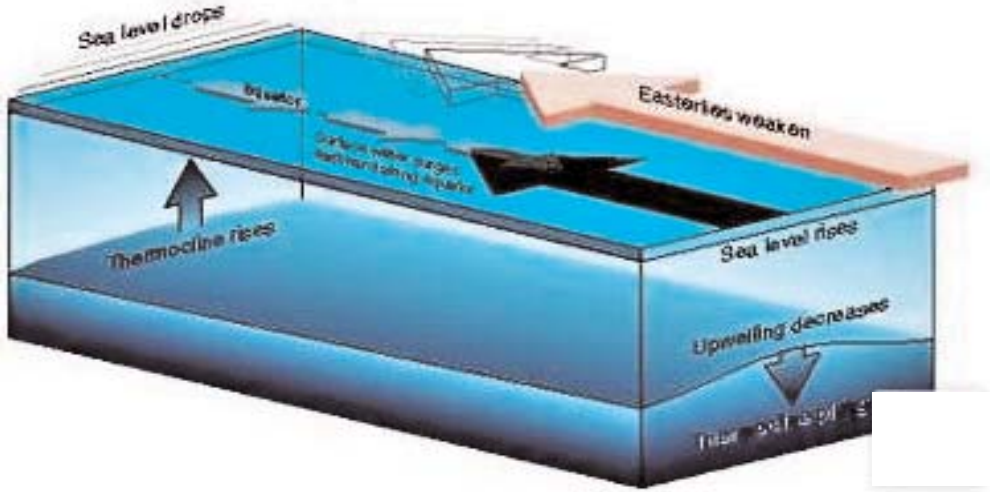


Figure 9 The trade winds (red arrow) that usually extend over the entire equatorial Pacific recede eastward when El Niño conditions occur. This triggers changes in the upper layer of the ocean. Along the equator, the slope of the surface and the slope of the thermocline both flatten.

becomes light enough to form thick clouds that produce heavy rain along the equator. This change in ocean surface temperatures is therefore responsible for the eastward shift of maximum rainfall over the central Pacific. the associated atmospheric adjustments correspond to a drop in pressure in the central and eastern Pacific, and an increase in pressure in the western Pacific (Indonesia and Australia), conducive to greater relaxation and greater retreat of the trade winds (Figure 11) .

The jolts of the dialogue which is established between the ocean and the atmosphere in the Pacific can affect by shock waves the climatic conditions in the most distant regions of the globe. This planetary-scale message is conveyed by shifts in tropical rainfall regions, which then affect wind patterns across the planet. One can imagine a current over large rocks. These rocks create wave trains, with troughs and ridges, which appear at fixed positions. If one of the rocks were to change position or shape, the shape of the wave train would be modified and the hollows and ridges would appear in different places (Figure 12).

The colors represent the hot water temperature in the west in the "normal" phase. Variations in the thickness of the ocean layer show variations in sea level. Under "normal" conditions, sea level is higher in the west (on the Indonesian coast) than in the east.

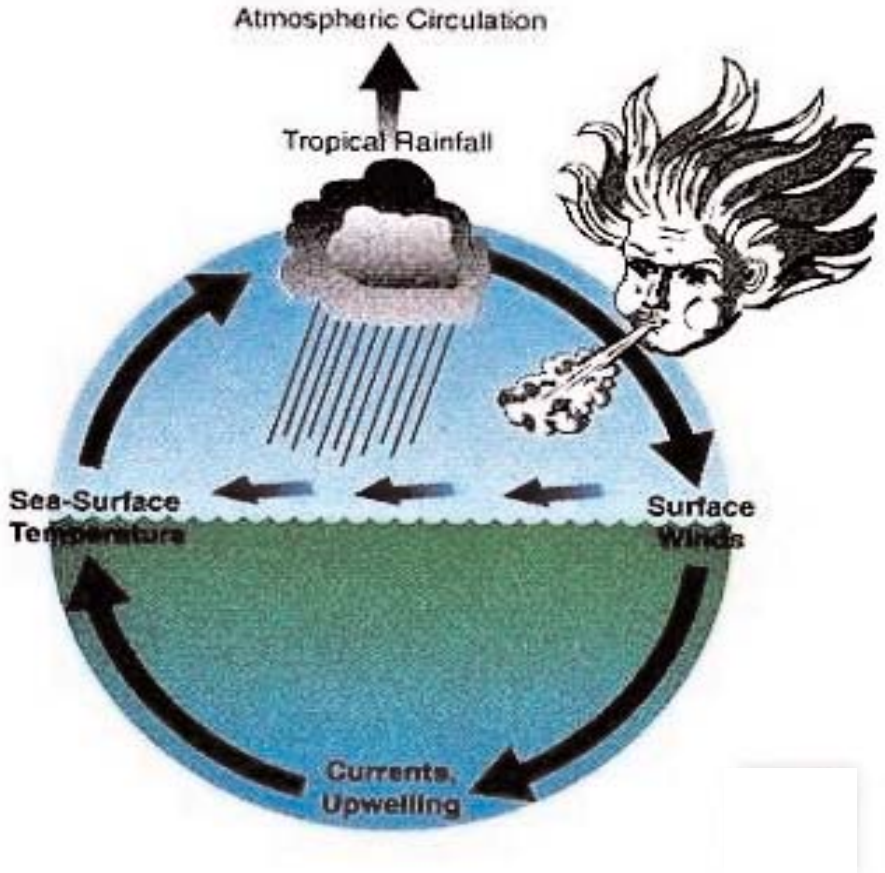


Figure 10 Like interlocutors engaged in a dialogue, the tropical Pacific Ocean and the atmosphere that covers it mutually influence and interact. Changes in the strength of the trade winds (east winds) along the equator induce changes in ocean currents and upwelling, which induce changes in sea surface temperature, which in turn alter the distribution rain, which alters the strength of the trade winds, ...

Also during the "normal" phase, the cold subsurface waters (in blue) are close to the sea surface in the eastern part of the basin (American coasts). During the El Nino phase, warm waters move eastward, sea level decreases in the west and rises in the east. Cold subsurface waters to the east are moving away from the surface.

Rain-bearing tropical clouds distort the air above them (8 to 16 km above sea level), like rocks affecting the course of a current or like islands changing the pattern of the wind blowing over them (over thousands of km). The waves that are formed in the air above these clouds will determine the positions of the monsoons, and the routes

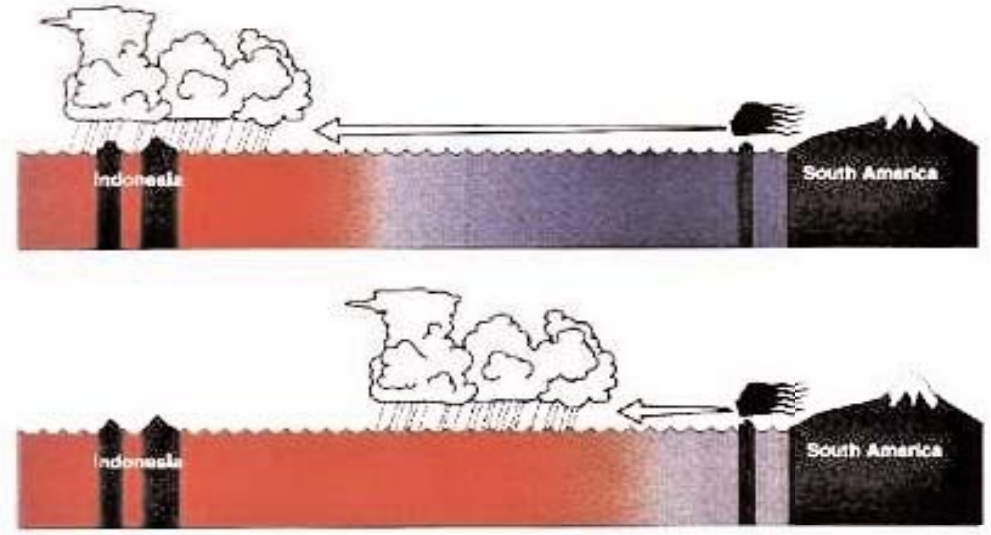


Figure 11 El Niño rearranges rainfall distributions in the equatorial Pacific. During normal years (top), upwelling induced by surface trade winds (arrow) keeps surface waters of the central Pacific cold (blue). The heavy rains are confined over the warm waters (red) that surround Indonesia on the western edge of the Pacific. During an El Niño (bottom), trade winds weaken and recede in the eastern Pacific, allowing the central Pacific to warm, and areas of rainfall to move east.

of the cyclones and belts of intense winds that overhang them ("jet streams") separating the hot and cold regions on the surface of Earth. During El Niño years, when the rain zone usually centered on Indonesia moves eastwards towards the central Pacific, the waves present in the upper layers of the atmosphere are affected, causing climatic anomalies over many regions. of the globe.

The impacts of El Niño on the climate at temperate latitudes are most evident during winter. For example, most El Niño winters are mild over western Canada and parts of the northwestern United States, and rainy over the southern United States (from Texas to

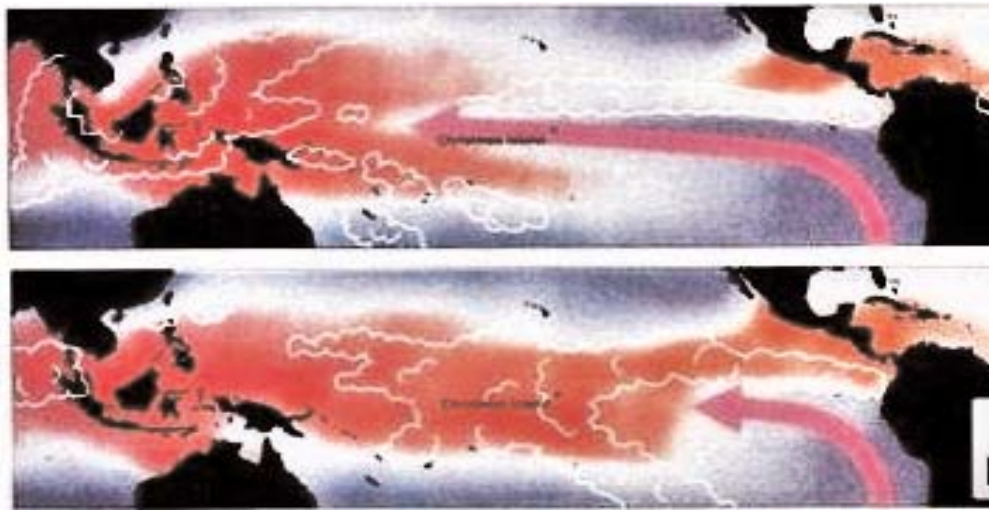


Figure 12 Here is a more detailed view of how El Niño rearranges the rain regions over the tropical Pacific. The colors indicate the distribution of sea surface temperatures for the cold month of November 1988 and for the warm month (El Niño) of November 1982, i.e. for the same months as those in Figure 4. Red corresponds to the warmest waters, and blue corresponds to the coldest regions. Areas of heavy rain, as seen by satellites, are indicated by clouds. Surface winds at the equator are indicated by arrows. Note the suppression of tropical precipitation where sea surface temperatures are below 27°C (bluish colours).

Florida). El Niño also affects temperate climates during other seasons. but, even during winter, El Niño is only one of many factors that influence the climate of temperate regions. El Niño years are

therefore not always marked by conditions as typical as those recorded in the tropics (Figure 13).

So far we have considered how an El Niño event develops, how it disrupts the marine world in the Pacific, how it influences climate patterns across the globe, and how abnormal atmospheric and ocean conditions affect us. Scientists are now taking knowledge of the phenomenon a step further by incorporating descriptions of past events into predictive models (computer programs designed to represent, in terms of equations, the processes that occur in nature). These models are fed with information, represented by numbers, which describes the current state of the atmosphere-ocean system (such as observations of wind speeds, ocean currents, sea levels, thermocline depths along the equator) (Figure 14). Forecasting models in turn produce sets of numbers (!) that may indicate how the system will evolve over the next few seasons or years (Figure 15).

Such models allow scientists to test their understanding of the behavior of complex systems, and for example to see if these models are able to simulate past El Niños. If the models turn out to be realistic enough, researchers can use them to make predictions of future climate.

Such numerical models based on the laws of physics have been used in meteorology since the 1960s for forecasting purposes. At first, these numerical forecasts were no better than those made by seasoned forecasters who relied only on their own experience to analyze and understand the weather. But, thanks to advances in our knowledge of climate systems and advances in the numerical models used to represent them, today's forecasting models consistently outperform the best forecasters.

Numerical El Niño models are not yet as good as those used in weather forecasting, but they are now able to reproduce the characteristics of a typical event. Recently, several research groups have invested in using these models to predict the onset and evolution of

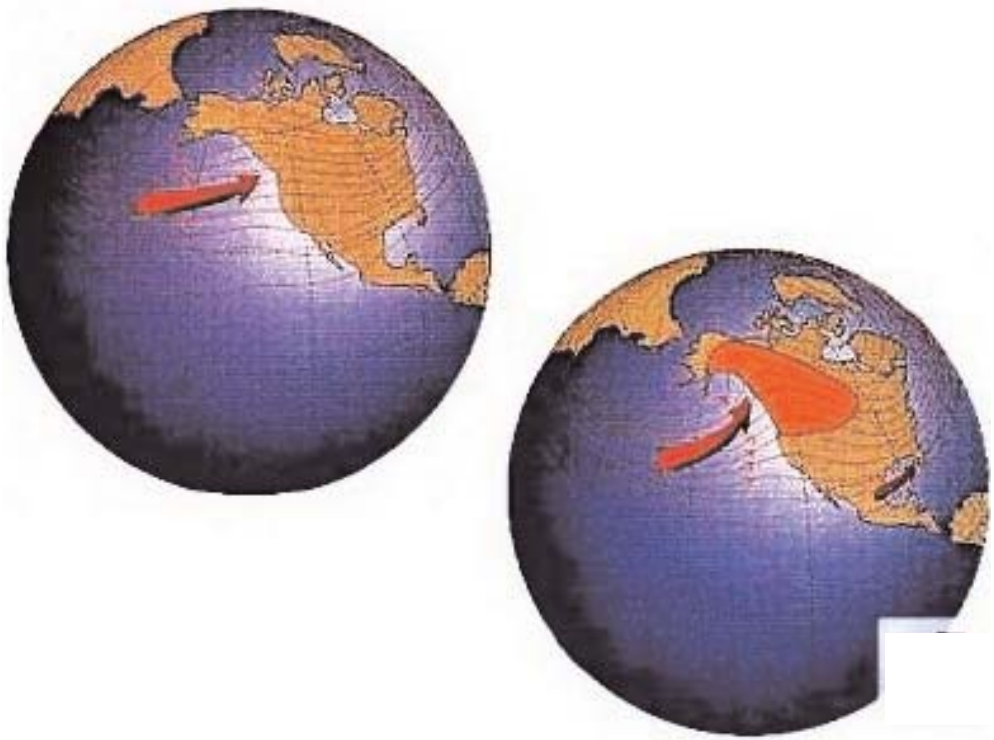


Figure 13 Winds at the jet stream (small black arrows), 8 to 25 km above sea level, change course between a normal winter (top) and an El Niño winter (bottom). A high pressure ridge present on the west coast of North America during El Niño winters preserves above normal temperatures in areas drawn in orange, and directs the thunderstorms that usually affect the states of Washington and Utah. Oregon further north, at the Alaskan coast (thick arrow). El Niño conditions also create a favorable environment for the development of thunderstorms in the Gulf of Mexico, bringing intense rainfall to much of the southern United States. A similar phenomenon of strengthening westerly winds occurs in the southern hemisphere during its winter, bringing heavy rains to parts of southern Brazil, and northern Chile and Argentina

individual El Niños, and their effects on weather patterns around the world, even before these El Niños have occurred. actually produced.

the results so far, although imperfect, give a better indication of the climatic conditions which will prevail during the following season(s) than simple reasoning based on the persistence of the phenomenon or on a systematic return to normal conditions.

An example of using forecasts

Peru provides an excellent example of the usefulness of El Niño forecasts, even in the short term. As in most developing countries in the tropics, the economy (and food production in particular) there is extremely sensitive to climatic fluctuations.

Year after year, the fluctuations between sea surface temperature along the coast of Peru above or below normal values produce a wide variety of local impacts. Warm years (El Niño) are rather unfavorable to fishing and some of them have been characterized by devastating floods in the coastal plain and on the western slopes of the Andes. Fishermen, on the other hand, rejoice in cold years, but not farmers who find themselves faced with droughts and insignificant harvests. Such cold years often occur after the occurrence of a strong El Niño. Thus Peruvians have good reason to be attentive not only to El Niño events, but rather to the two extremes of the El Niño cycle.

Even before flooding from the phenomenal El Niño of 1982-83 had completely subsided, farmers in Peru were already beginning to fear that ocean surface temperatures would fall below normal the following year, bringing drought and a shortfall in crops. It was at this time that the Peruvian government decided to develop a program capable of predicting future shifts in the climate.

The first task was to make a forecast for the next rainy season, expected in early 1984. Information available in early November 1983 indicated that climatic conditions in the equatorial Pacific were close to normal and were likely to remain so throughout the season. rainfall, thereby favoring agriculture. This information was passed on to numerous organizations and the Ministry of Agriculture, which incorporated it into their plans for the coming 1983-84 growing season. The forecast turned out to be correct, and the harvests were abundant. Since then, forecasts for the coming rainy season have been issued each November, based on observations of winds and ocean temperatures in the tropical Pacific region, and from numerical models. the forecasts are presented in the form of 4 possibilities:

Near normal conditions.
* A weak El Niño with a slightly wetter than normal growing season.

* An intense El Niño, with flooding.

* Cooler than normal coastal waters, with a higher likelihood of drought.

Once the forecast is issued, farmer representatives and the government meet to decide on the appropriate mix of plants to sow in order to maximize the overall yield. Rice and cotton, two of the main plantations in northern Peru, are very sensitive to the amount and timing of rainfall. Rice thrives for wet conditions during the growing period, followed by drier conditions during the ripening phase. Cotton, with its deeper root system, can tolerate a drier climate. Therefore, a forecast of an El Niño winter may tell farmers to plant more rice and less cotton than for a winter in a year without El Niño.

The future

Peru is one of many countries already successfully using El Niño forecasts in conjunction with agricultural planning. Other countries that have taken similar initiatives include Australia, Brazil, Ethiopia and India. It is no coincidence that all these countries are located at least partially in the tropics. Tropical states have much to gain from successful El Niño forecasts because they are affected by a major

fraction of the impacts summarized above, and because they occupy regions of the world where model accuracy of climate forecasting is precisely the best. But for other countries outside the tropics, such as Japan and the United States, more accurate El Niño predictions will help strategic planning in areas like agriculture or water resource management or reserves. wheat and oil (used for heating purposes). Encouraged by the progress made over the past decade, scientists and governments in many countries are working together to design and realize a global system to:

* Observe the tropical oceans.
* Forecast El Niño and other irregular climatic rhythms.
* Make systematic climate forecasts, immediately available to those who need them for planning purposes, in much the same way that weather forecasts are released to the public today.
* The ability to anticipate climate changes from one year to the next will lead to better management of agricultural production, water reserves, fisheries, and other resources. By incorporating climate forecasts into management decisions, humanity becomes better prepared to deal with the irregular rhythms of climate.

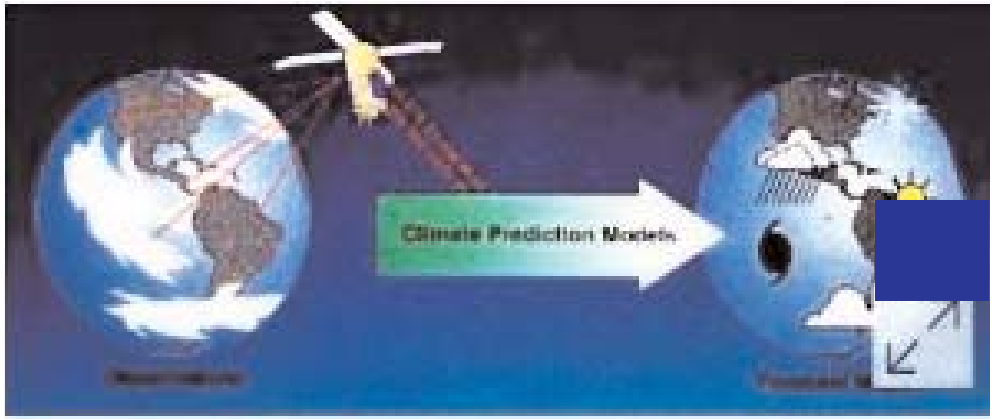


Figure 14 Quality (non-error) data on current conditions, and realistic numerical models to project this state into the future, are central to researchers' efforts not only to understand El Niño, but also to predict when events will occur in the future, and what their impacts will be.

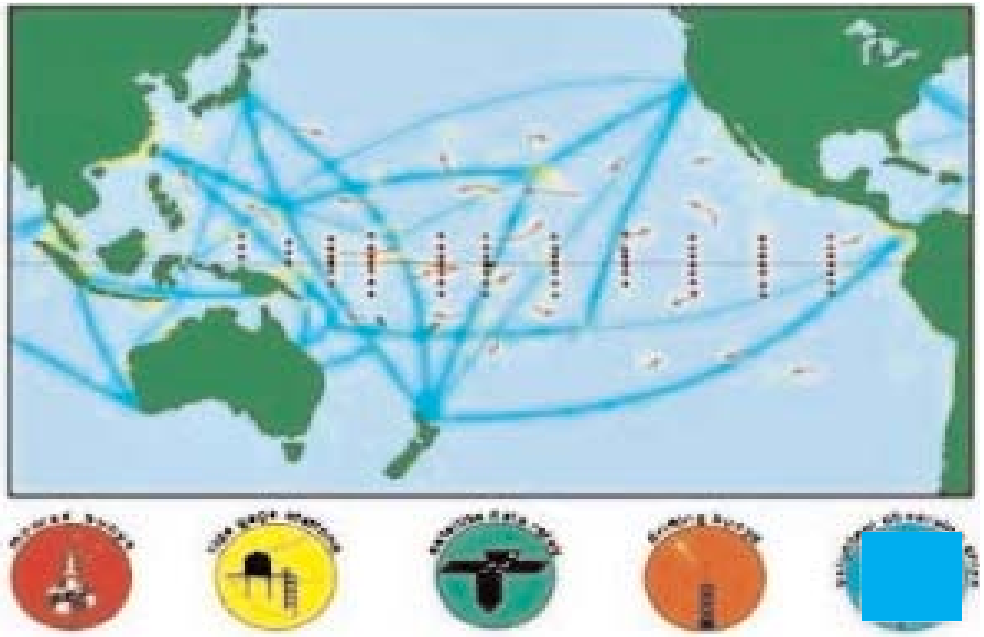


Figure 15 This diagram represents some of the components of the ocean observing system that have been deployed to assist in the prediction of El Niño. The red dots correspond to automatic readings of sea level. The yellow squares and diamonds show the location of fixed buoys (anchored to the sea floor) providing control of surface winds and other atmospheric quantities, as well as as measuring the temperature of the ocean at different levels. They operate continuously for months without human intervention. The pink arrows describe the trajectories of drifting buoys, measuring the temperature of the ocean and providing information on the movement of surface waters. The blue lines represent the lines of merchant ships that are willing to make vertical profiles in the ocean (using disposable bathythermograph probes) Most of these observations are sent directly by satellite to weather forecasting centers scattered around the globe .

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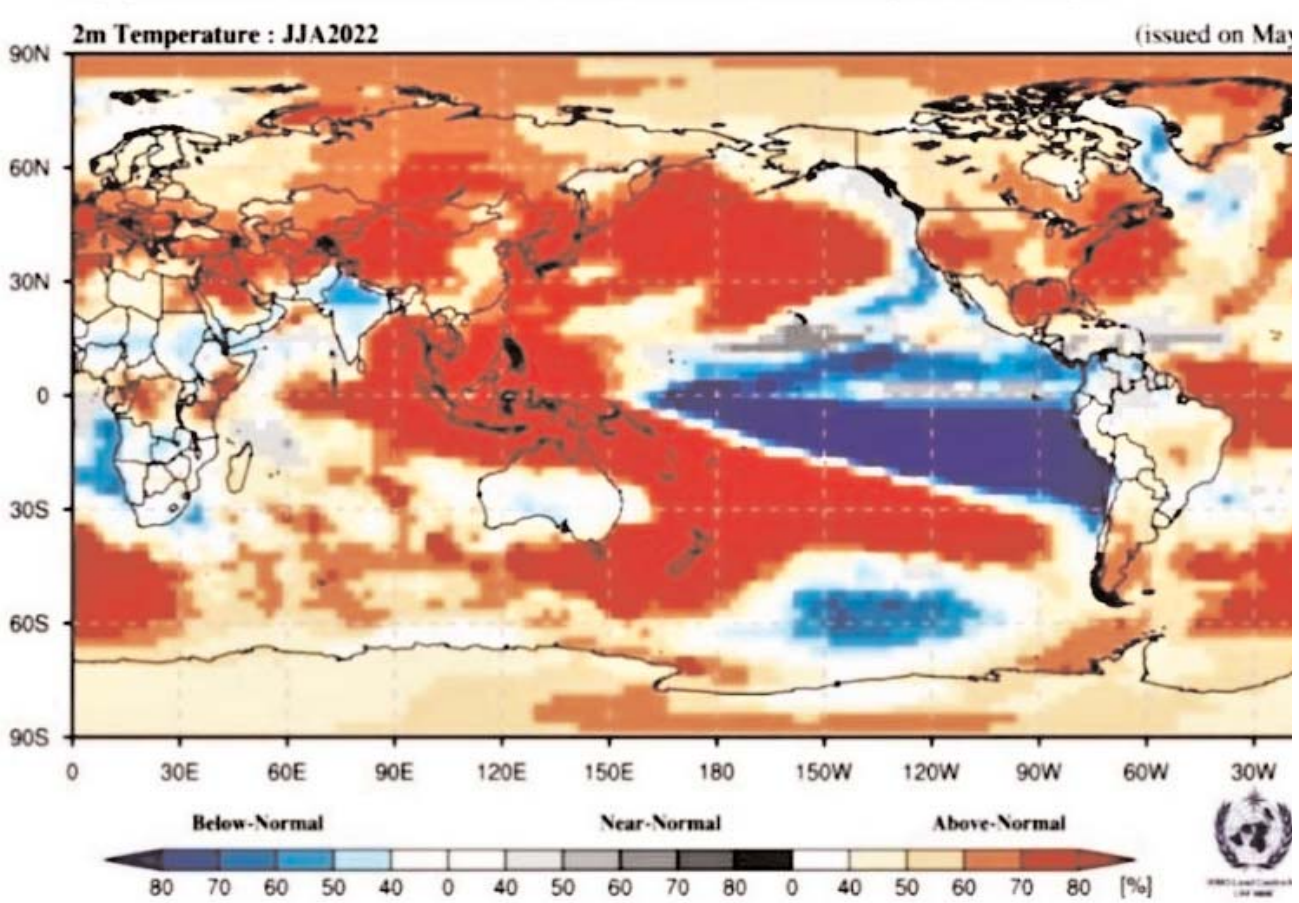
directly influences the weather in some part of the world. This is a cooling of the waters of part of the Pacific Ocean which has an impact on the temperatures and precipitation of the United States, South America, Australia, or even a part of Asia.

The phenomenon has persisted since 2021, with a particularly strong intensity and its consequences have been dramatic for several regions of the world in 2022: accentuation of the already historic drought in the American West and the Horn of Africa, heat wave in full winter in the southeastern United States, very active hurricane season in the Atlantic, torrential rains and catastrophic floods in eastern Australia, long-lasting heat wave in India and Pakistan last spring...

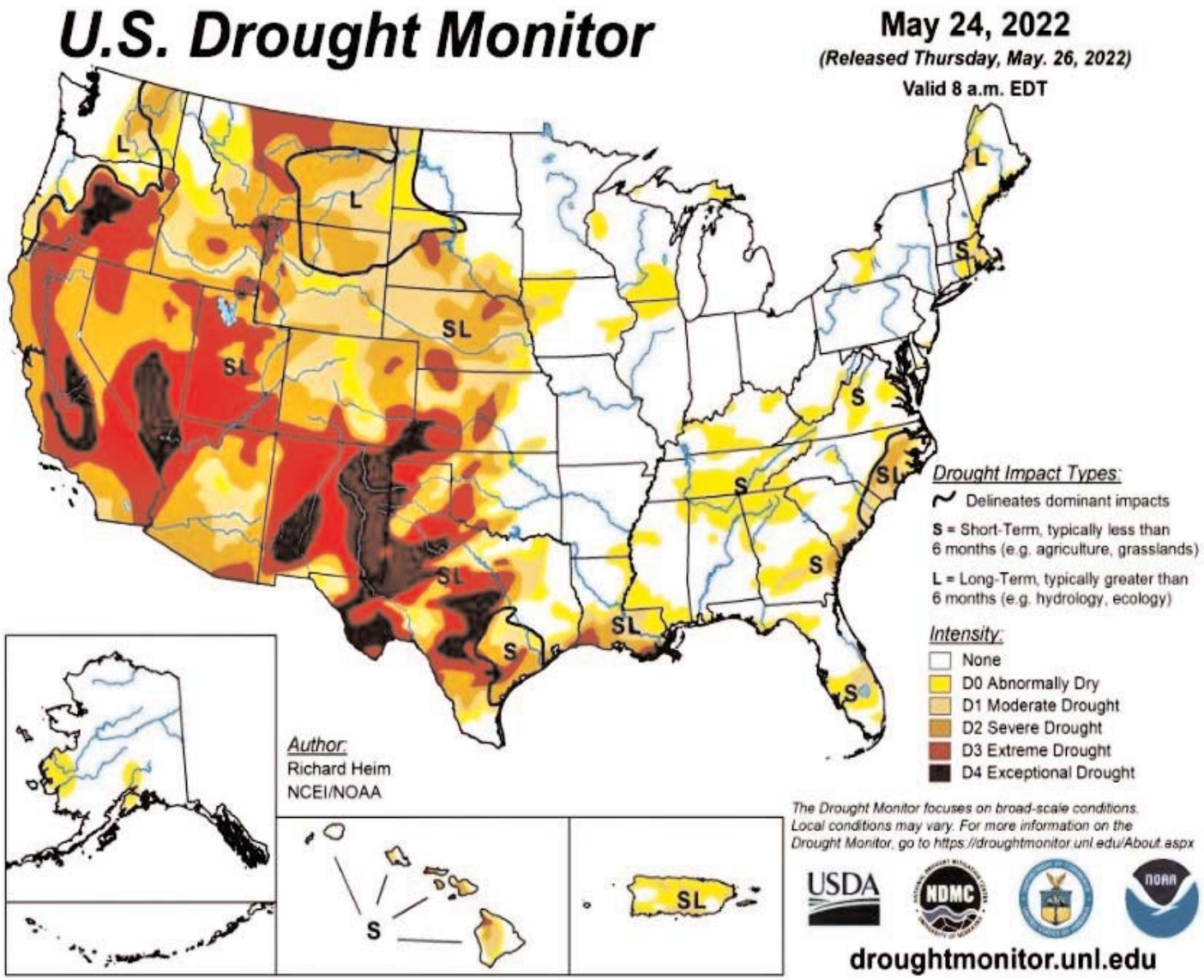
La Niña appears in phases of one to two years, alternating with its warm counterpart El Niño (which has other consequences). While La Niña has suffered several drops in intensity since September 2020, before rising sharply (especially last spring), meteorologists and climatologists expected to see it gradually fade, either during the summer or in the fall.

However, in a press release dated June 10, the World Meteorological Organization (WMO) announced that there is now a 70% chance that La Niña will extend beyond August. Moreover, long-term forecasts even indicate that the episode could persist until 2023, or even strengthen during the winter. If true, it would be the third 'triple La Niña' (three consecutive Northern Hemisphere winters under the La Niña regime) since 1950, according to the WMO. These forecasts for 2023 will need to be confirmed at the end of next summer, but the specter of a "triple La Niña" appears more and more likely. If La Niña persists for the third consecutive year, the event would then become remarkable in terms of climate: this has already happened in the past, but remains very rare. La Niña occurred 28% of the time between 1950 and 1999, the other 72% of the time was occupied by El Niño.

Coupled with global warming, the effects of La Niña are multiplied. The El Niño and La Niña phenomena are determinants of the Earth's climate system, although they are not the only ones. Climate forecasts from the World Meteorological Organization (WMO) aim to help governments, the United Nations, decision-makers and actors in climate-sensitive sectors to prepare (agriculture and infrastructure), as well as to protect the lives of citizens. .
Remember that La Niña tends to cause a slight cooling of the global climate: we can therefore think that the rise in temperatures,



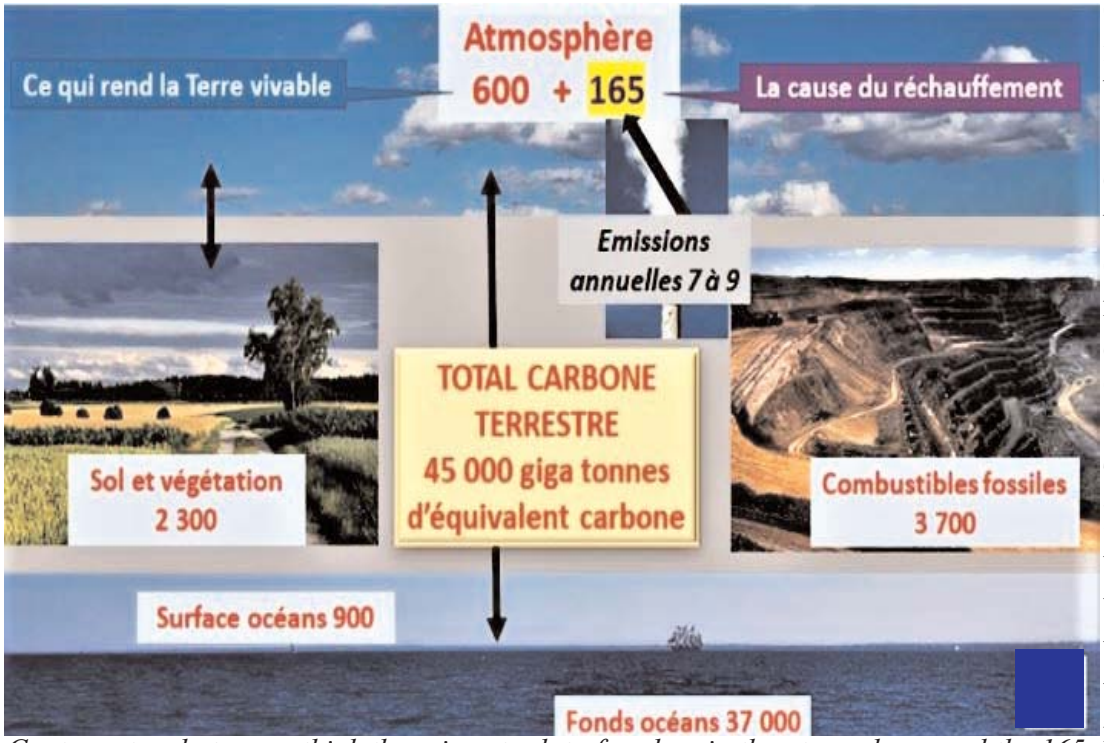
although already worrying, could have been limited by the phenomenon. The recurrence of the phenomenon could also be linked to the Pacific Decadal Oscillation (PDO): this is a variation in sea surface temperature in the Pacific that occurs in cycles of several decades (20 to 30 years). This variation influences major weather systems. La Niña is more costly than El Niño for the USA and Australia: droughts and forest fires in the American West, for example, cost twice as much with La Niña as during an El Niño year. In general, when the phenomenon persists for two years in a row, the second year is weaker because the system is weakening. But La Niña suddenly strengthened in the fall of 2021 after a dip in the spring. It then experienced a record intensity (linked to the temperatures recorded in the ocean) between winter and the beginning of spring: at a time when American water reservoirs should have been replenished by the rains, the drought worsened . The recurrent episodes of drought in the western United States also correspond to the last 22 years marked by the incessant return of La Niña.



La Niña is the first phenomenon that influences the American climate: "The persistence of La Niña is surely the main factor of the historic drought in the United States [but] if La Niña could easily be responsible for the worst drought for 300 years, for what is the worst drought in 1,200 years that we are currently experiencing, La Niña has clearly been helped by climate change". As often in the climate, it is the concomitance of several factors which makes it possible to explain a phenomenon.

Carbon on our planet From the atmosphere... to the ground

Atmospheric carbon is not an evil in itself: it is what makes our planet livable... but everything is in the quantity: remember that on the planet Mars, which no longer has an atmosphere and therefore no gas greenhouse gas, it is -50° Centigrade on average, and on Venus, which has clearly abused the greenhouse gas, +420°). The temperate nature of our Planet comes from the fact that there are approximately 600 billion tonnes of oil equivalent permanently above our heads; and the disadvantages of global warming come from the extra 165 that we have sent since the beginning of the industrial era; we must therefore find a way to reduce these 165 billion undesirable tonnes.


Atmosphère
600 + 165
Ce qui rend la Terre vivable
La cause du réchauffement
Emissions annuelles 7 à 9
TOTAL CARBONE TERRESTRE
45 000 giga tonnes d'équivalent carbone
Sol et végétation 2 300
Combustibles fossiles 3 700
Surface océans 900
Fonds océans 37 000

Contrary to what many think there is not a lot of carbon in the atmosphere, and the 165 GtC which unduly warms the planet only represents a very small part of it. © Editing Bruno Parmentier (Barocca , Stephen Codrington, Ulleo , wikimedia commons CC 3.0 , Ricwood , Pixabay , DP

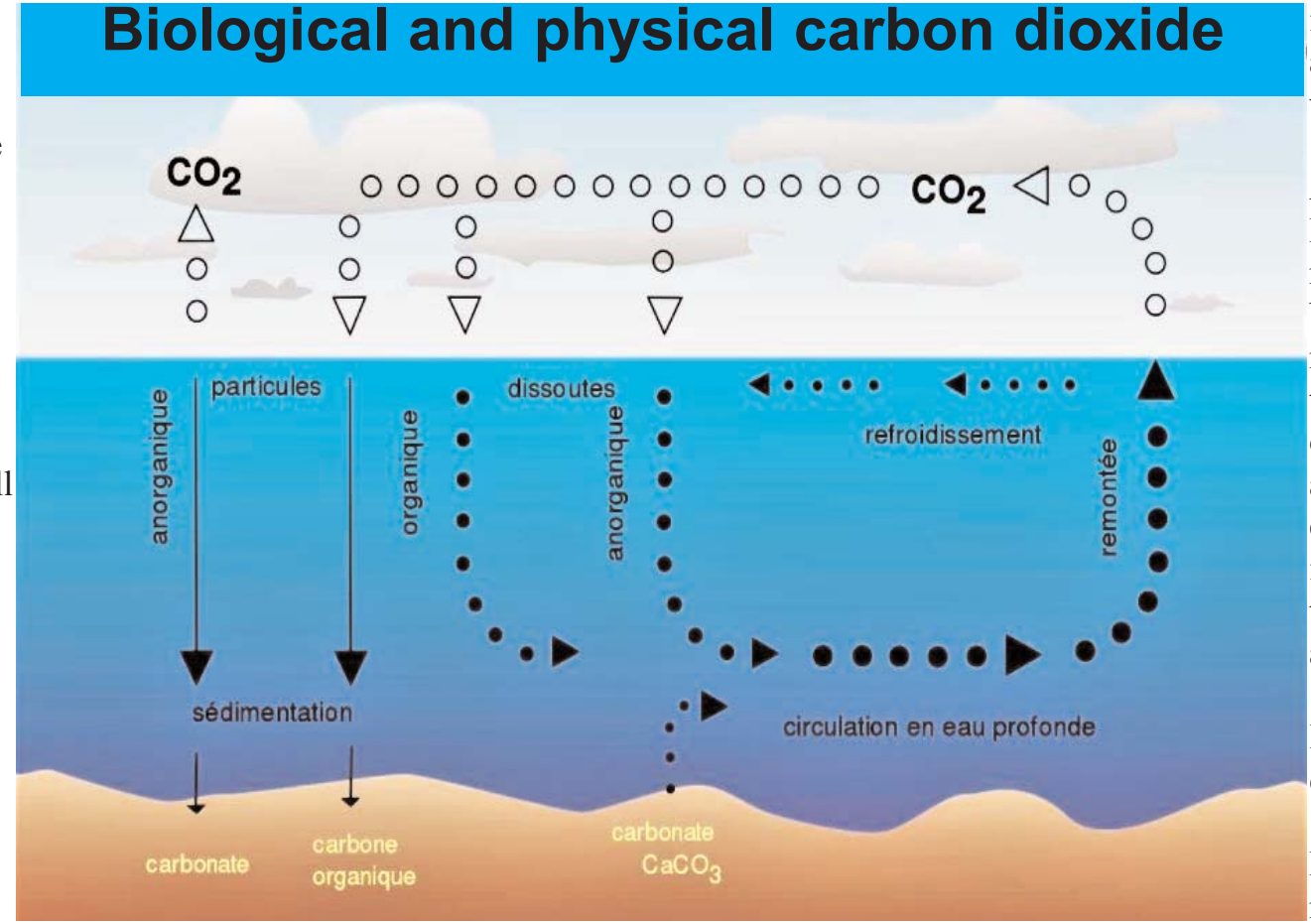
In fact, by far, far away, most of the planet's carbon is stored in the sea or under the sea, in tonnages significantly greater than those of the atmosphere, in fact approximately 50 times more.
The stock of fossil fuels (all aggregated: oil, gas, coal) was worth about 3,700 billion tons of carbon in 1750 - before we started to dip into it. Since then, we have exported a few hundred billion tonnes, so in fact a very small part of the stock! When we predict the end of fossil fuels, it is in fact a stylistic clause because there are still a lot of them, six times more than there are in the atmosphere! And so, we can really destroy the planet if we continue this irresponsible exploitation. For example, we had the impression a few years ago that there was more oil and that we were going to run out of it seriously. It was ignoring our ability to exploit oil shale which, for example, means that the United States of America is now an exporter and no longer an importer of oil and gas. It's basically that carbon that got stored in the atmosphere and caused a lot of problems for us. And, despite all our efforts, which therefore remain totally insufficient, we continue to dump around 6 to 9 billion tonnes each year.

The rest of the carbon is located in continental ecosystems, ie around 2,300 billion tonnes. This is two-thirds of the carbon stored in agricultural land, at a depth of a few meters, and the remaining third in the vegetation that has grown on this land, and of course especially the 3,000 billion trees. Let's remember this order of magnitude: there is currently four times more carbon in and on our soils than in the atmosphere!

We see that it is only the 165 billion tons added to the atmosphere that poison our existence, that is to say barely 0.5% of the approximately 45,000 existing on the planet. This shows the very great fragility of the latter, and also sets a roadmap for the future. We should be able to act, therefore we must!

Carbon exchanges between seas and atmosphere are important, can we accelerate the capture process?

The idea would be to significantly increase the storage of carbon in the seas and oceans, since the vast majority of the carbon present on earth is in fact dissolved in the sea.



Plankton, corals and fish indeed absorb carbon dioxide and their waste and corpses eventually fall in a continuous "rain", called "sea snow" on the seabed. What is not consumed by the deepest organisms slowly forms sedimentary rocks, which fixes carbon for millions of years in the form of rocks. Given the huge areas involved, it is estimated that this phenomenon fixes about half of the carbon dioxide that is absorbed on the planet. However, this point is still subject to controversy fueled by partial and contradictory studies, some finding that the seas sequester more carbon than previously thought, others demonstrating that in fact they release a lot. In reality, we realize that we know very little about this environment. To begin with, in the current state of technology, we do not really know how to store more carbon there. One of the ideas that have been put forward would consist of spreading microparticles of iron or iron sulphate to boost the sequestration of carbon by the ocean thanks to plankton. Some experiments have been done, in particular in 2002 in Antarctica, which gave hope that for each iron atom spread, between 10 and 100,000 carbon atoms could be fixed. It is therefore feared that the disadvantages of this additional storage are very significant, in particular in the acidification of seawater...

A solution
Plowing has been the most powerful symbol of agriculture for millennia, so much so that farmers have often been referred to as "ploughmen"! But, come to think of it, it is a real heresy in terms of energy balance.

Plowing called into question

Plowing also has many other disadvantages: it destroys the life of the soil which is nevertheless essential to agriculture: bacteria, fungi, earthworms, etc., and it promotes erosion and soil compaction. , water runoff, etc. When you dig a trench in a field you can clearly see what is called the hard "plowing sole" is absent of any biodiversity, on the first 50 centimeters; life begins below, but annuals have a hard time getting there!
And even its main raison d'être: to eliminate weeds, is a service that it renders very imperfectly, since the seeds of weeds buried in this way can remain buried for five to seven years with impunity without rotting; what we pushed in year N will therefore inevitably come out and in excellent shape in year N+1!

It is quite obvious that if we activate photosynthesis during the summer instead of leaving the fields bare, we capture a lot more atmos-

pheric carbon, which is then intended to remain in the ground, and therefore we actively contribute to cooling the planet! We see here direct seeding in these cover crops, which turn into fertilizer, after having captured as much nitrogen and atmospheric carbon as possible.

Changing practices for soil conservation agriculture
In fact, by practicing this so-called soil conservation agriculture, we kill two birds with one stone: we maximize the efficiency of photosynthesis by capturing a lot more carbon, and we protect the life of the soil, which makes us feel good by digesting a lot more. effectively the vegetation thus produced to really fix this carbon in the soil; and in the end, a soil loaded with carbon and micro-organisms of all kinds is much more fertile.

In addition, no-till agriculture could in Europe lower the extreme temperatures of heat waves by up to two degrees, thus offering an option to reduce the effects of global warming. No-till allows residues to remain on the land after harvest, which reflect much more solar radiation, thus reducing the amount of heat absorbed.

An example is provided by permanent grasslands: they accumulate enormous quantities of organic matter, essentially in the form of roots and micro-organisms, in a relatively stable manner over long periods of time, since they are not plowed or fertilizer application. But around the world, since 1850, much of this grassland has been converted to fields or urbanized, thereby losing large amounts of carbon through oxidation. The quantities captured depend on the type of species being cultivated; among grasses, it seems that red fescue is one of the most effective, but in this respect, the secret is the mixture of complementary species: a good pasture often has several dozen of them, between grasses and legumes.

For a sustainable and adapted transition
With these new agricultural techniques, we can therefore engage in a real virtuous circle, and pursue three goals at the same time: feed humanity, improve soil fertility and biodiversity, and cool the planet!

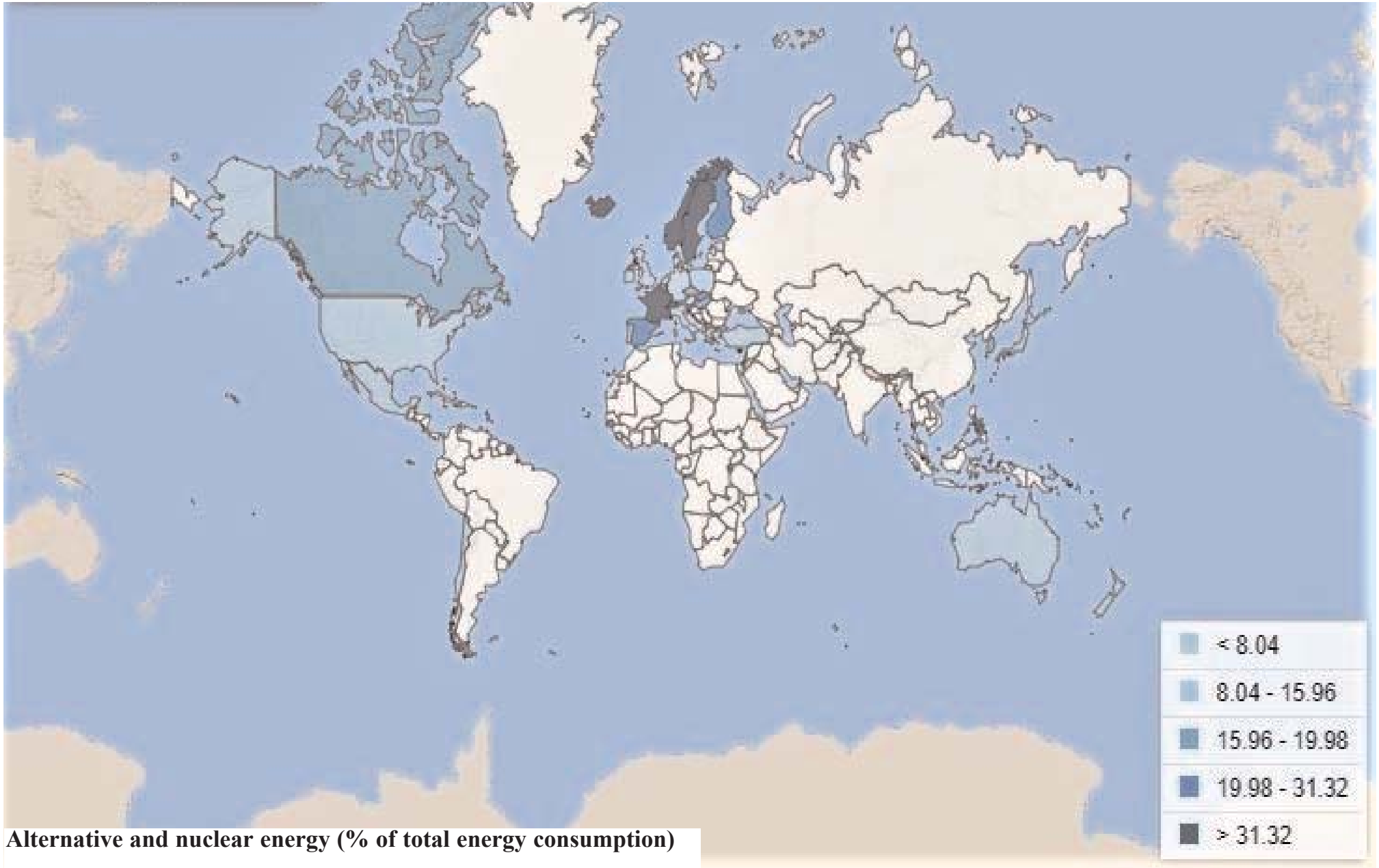
Note however that this virtuous technique needs to be continued over a long period, because in fact the storage of carbon in the soil is temporary and reversible; any abandonment of this practice leads to the opposite movement of carbon mineralization and destocking... If we set up public support systems for this activity, they must therefore be sustainable!

All in all, it is therefore through a combination of multiple techniques that agriculture can begin to store carbon again: planting forests and hedgerows of course, but more generally agroforestry, permanent soil cover, direct seeding, natural grassland, grassing of orchards and vineyards, etc. And let's underline that this technique absolutely does not prevent us from producing food for our contemporaries!

It is estimated that 4.2 million people die each year worldwide due to air pollution. Fine particles, with a diameter less than or equal to 2.5 microns (PM2.5), are a frequent source of air pollution. These particles are about 1/30th the width of a human hair and are made up of dust, residue, smoke and heavy metals. Their tiny size makes them particularly dangerous, as they can creep into the airways and cause lung cancer, stroke, heart disease and other serious conditions.

The end of fossil fuels?

But if the end of the era of fossil fuels is not necessary because of the foresight of men regarding the depletion of resources, it is now necessary because of excess atmospheric emissions. The climatic risks linked to the increase in the greenhouse effect are such that imperative measures to reduce the use of fossil fuels are essential. In developed countries like France, we will have to divide our emissions by four in about fifty years. This implies reducing the use of fossil fuels - oil and gas - by looking everywhere for sectors where they can be replaced.



Alternative and nuclear energy (% of total energy consumption)

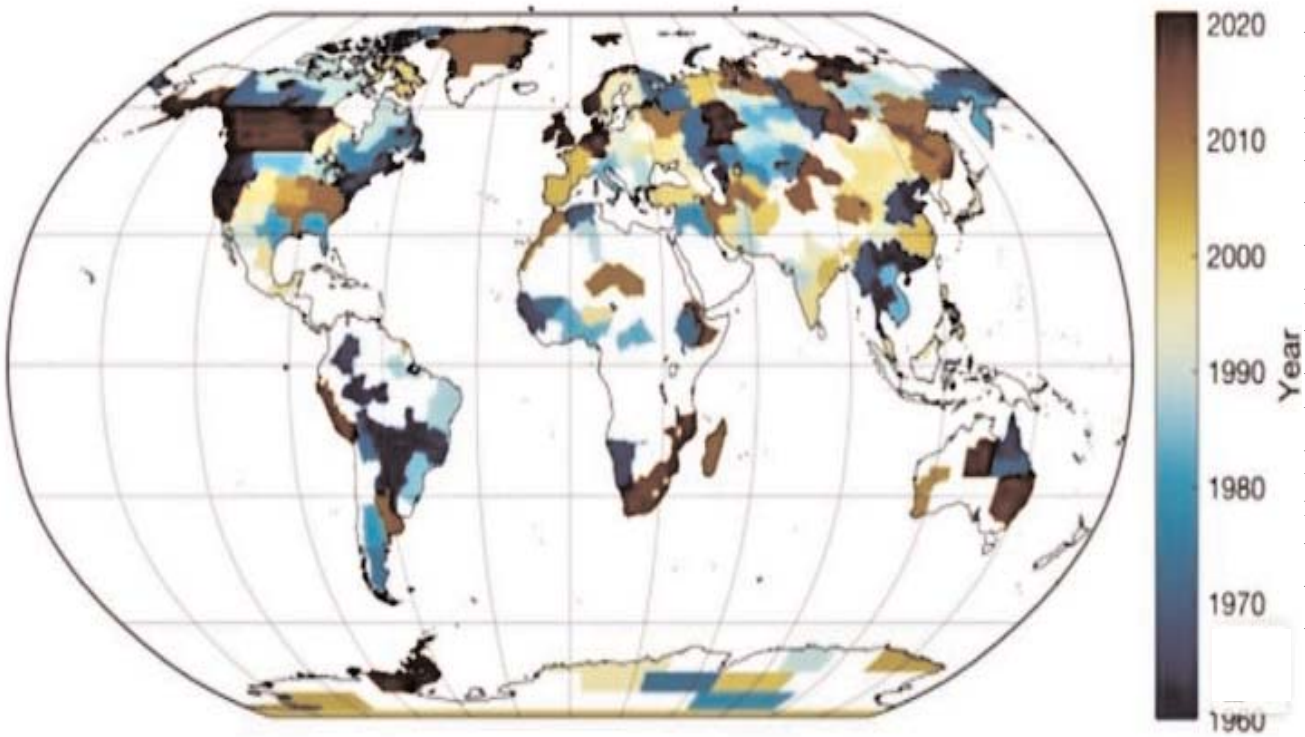
Heat waves

Heat waves are natural phenomena that are part of our climate system. However, with human-induced temperature rises, these waves promise to be warmer, longer lasting and spread geographically.
Long and extreme heat waves are a threat to human health (estimate of six deaths per 100,000 inhabitants every year in North America for 2000-2019) and to the health of our environment, which makes them an important subject of study. .

Instances of heat waves in North America are well known, with records of 49.6°C broken in June 2021 in Lytton, British Columbia; which represents an increase of 4.6°C compared to the previous heat peak. However, a new survey published in Sciences Advances, by a team of researchers from the University of Bristol, reveals that there have been five other more devastating heat waves since 1960 that have gone unnoticed.

The most extreme heat waves since 1960
These heat waves are not the highest recorded temperature values, but are defined as heat peaks that are significantly higher than the average temperature a region usually experiences.

Of these waves, the three hottest on record were in Southeast Asia with 32.8°C in April 1998, Brazil with a peak of 36.5°C in November 1985, and the southern United States. United with 38.4°C in July 1980.



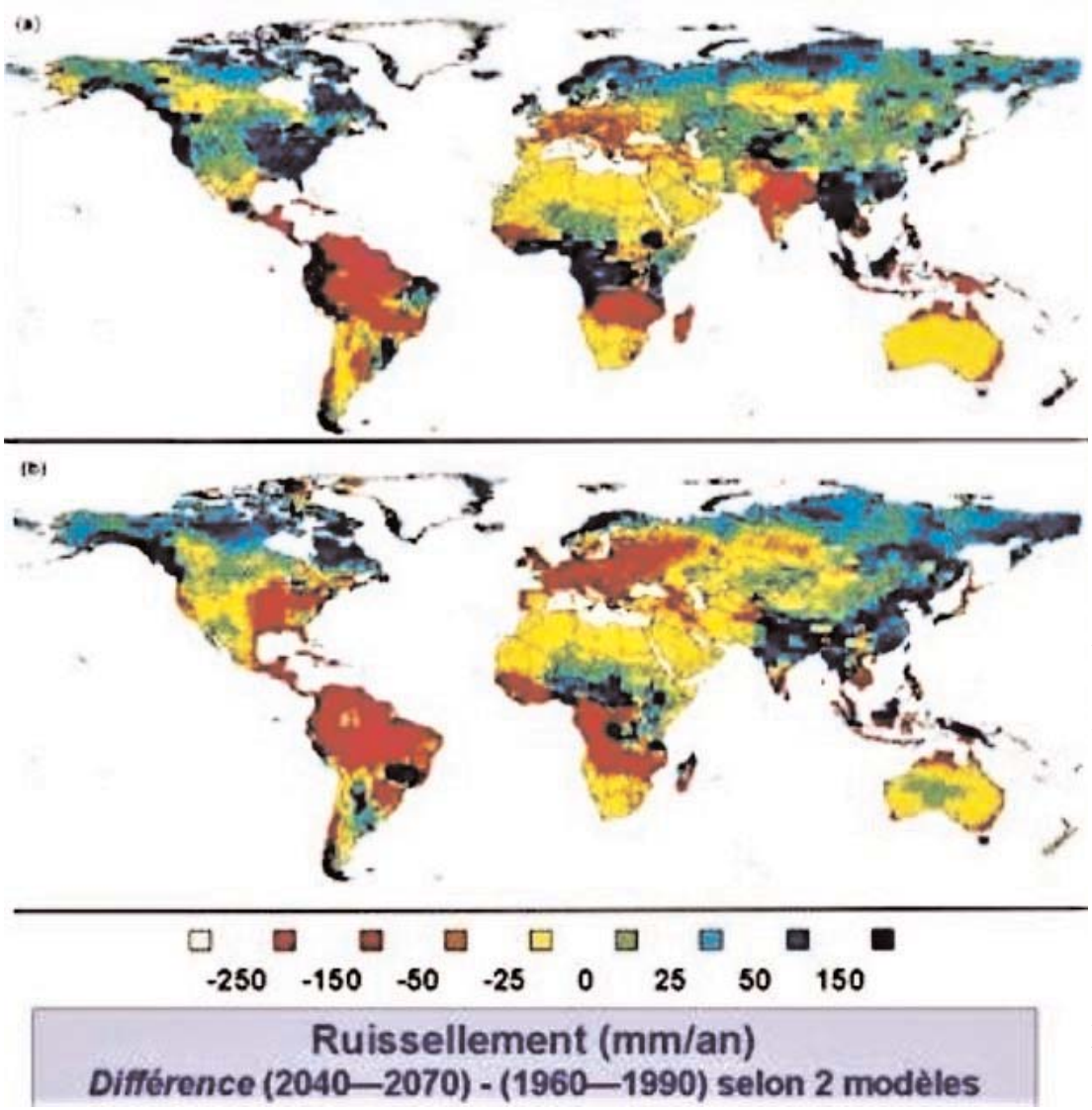
Year in which the greatest historical extreme occurred between 1960 and 2021

The reason why these waves went unnoticed would probably come from their occurrence in more disadvantaged countries. However, it is necessary to identify and assess the damage that these heat waves can cause, in relation to the variability of the local temperature. Indeed, we need to have a better understanding of climate extremes so that our species and ecosystems can adapt and be less vulnerable. It is for this purpose that the team of scientists from the University of Bristol modeled the behavior of heat waves for the rest of this century. The most glaring observation from these simulations is that the intensity levels of heat waves will increase with the rise in global temperatures.

It's not just the warming

We risk seeing a new deal for freshwater, but we do not yet know which one. Will there be more or less fresh water available in India? east of the Mississippi?

All projections give more water in the Nordic countries, where precipitation is expected to increase. For the rest of Europe, the calculations predict less water on average, but some calculations give much less.



Furthermore, what will become of the risks of flooding? This depends in many cases on rare episodes of particularly heavy precipitation, and in some cases the risk of severe flooding may increase even if the average precipitation decreases.

By evoking the possible changes in the runoff, we have entered into the complexity. It is certainly useful to begin the study of climatic processes in terms of solar irradiation, the parasol effect, and the greenhouse effect, all being considered as a global average (average over the surface of the globe, average over the 'year).

However, this remains an oversimplification. Climate is a matter of non-uniformly distributed solar energy fluxes across the globe, varying greatly with latitude, seasons, and time. These non-uniformities act as a motor for the circulation of the atmosphere, and the atmospheric movements set in motion the ocean currents, all these movements being affected by the Coriolis force due to the rotation of our planet. The unevenly distributed solar energy, absorbed and converted into heat, especially in the tropics, is redistributed by the circulation of the atmosphere and marine currents from the oceans to less favored areas.

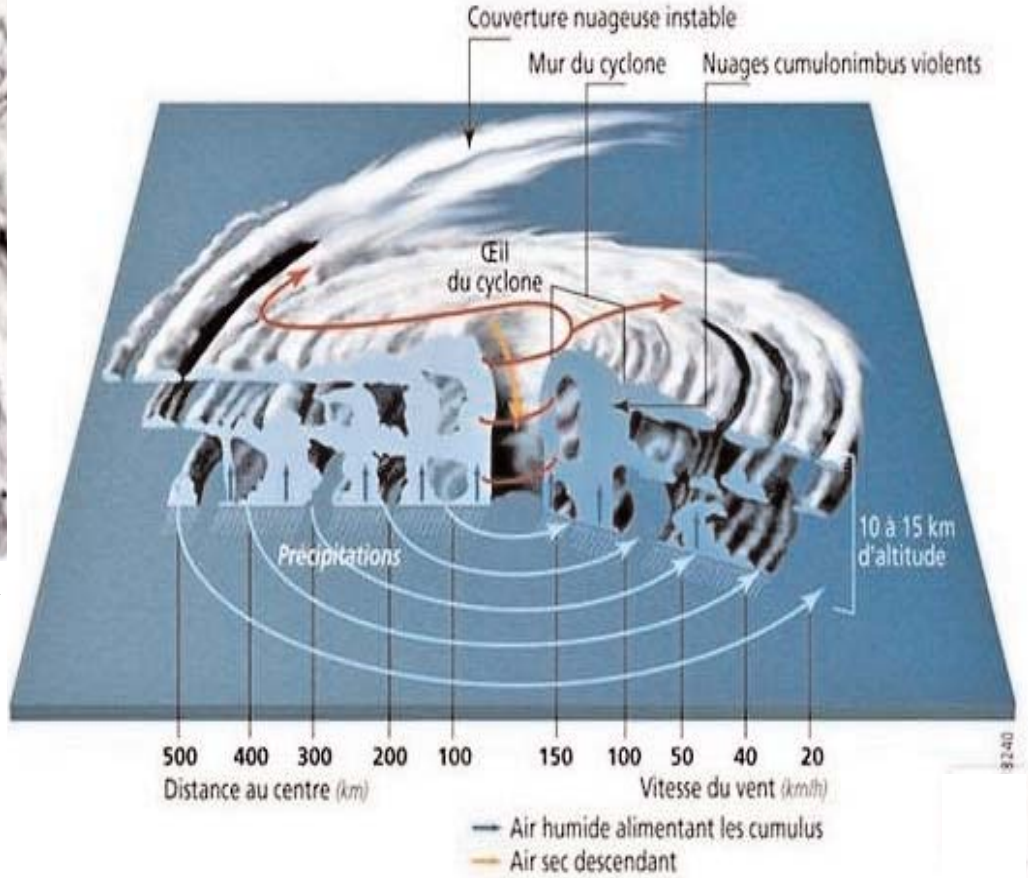
The purely global approach does not make it possible to understand the great alternations between glacial and interglacial periods (whose diagram above shows the last 420,000 years). The rhythm of these alternations depends on very small variations in the Earth's orbit and in the inclination of its axis of rotation, which modify the distribution of solar irradiation with latitude and seasons. But if these so-called Milankovitch variations control the rhythm of the alternations, the amplitude of these climatic changes depends on feedbacks on the one hand from the extent of the ice on the parasol effect, on the other hand from the composition of the atmosphere. (mainly water vapor and CO2) on the greenhouse effect.

ITHERE'S A STORM IN THE AIR

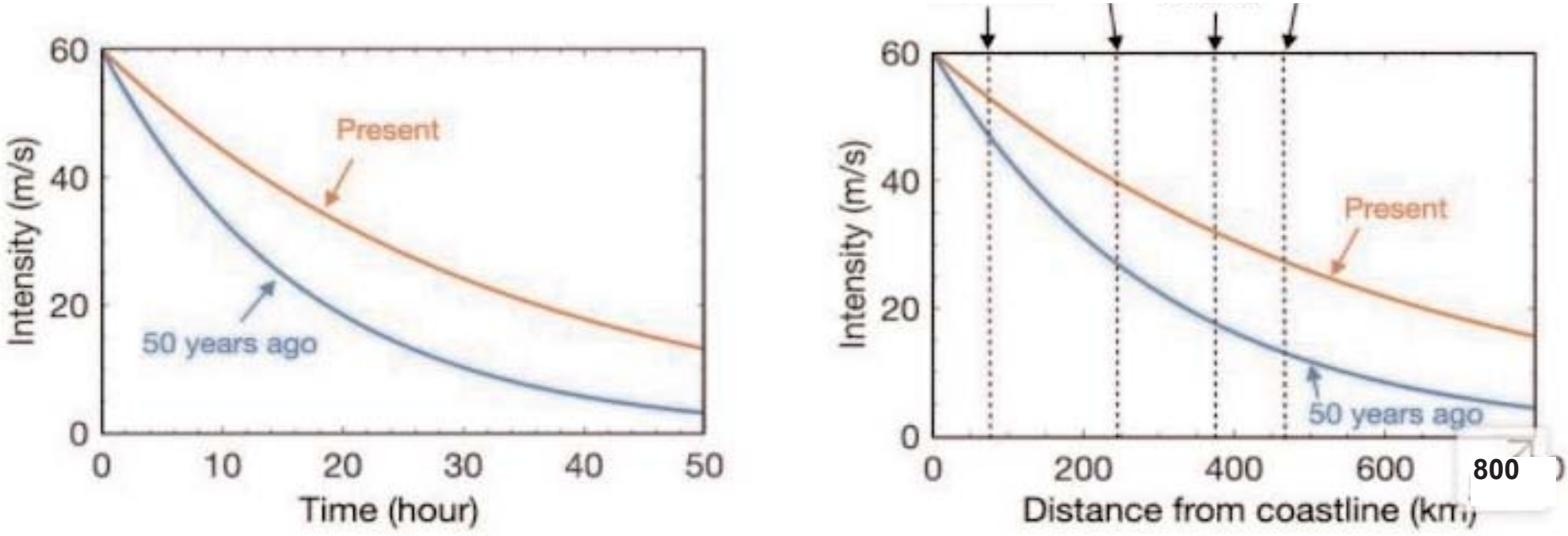
Typhoon, hurricane or cyclone. These three terms describe the same reality that is simply played out in different places on the globe: North-West Pacific for the first, North Atlantic and North-East Pacific for the second and Indian Ocean and South Pacific for the third. In almost all parts of the world where these types of weather phenomena form, they have become more powerful over the past 40 years. If we fail to limit global warming, hurricanes will cause more and more damage and cost more and more lives.

For hurricanes, the moisture absorbed from the surface of the ocean is the "fuel" that intensifies and sustains the destructive power of a hurricane, as the heat energy of the moisture is converted into powerful winds.

Researchers analyzed North Atlantic hurricanes that made landfall between 1967 and 2018. To find that while hurricanes weakened by 75% on the first day after landfall 50 years ago, they are now only weakening more than 50% at the same time. Hurricanes that are twice as intense and last twice as long. According to a law that appears to follow changes in sea surface temperature. Hurricanes that develop over warmer oceans can absorb and store more moisture, preventing them from weakening as quickly. And this stored moisture also makes hurricanes rainier.The researchers estimate that the likelihood of a hurricane evolving into a major hurricane -- category 3 or higher on the Saffir-Simpson scale with winds of more than 180 km/h -- has increased by 8% each decade. Bad news when you know that the damage caused by this type of event explodes with their intensity. And that global warming also seems to make them evolve more quickly and accompany them with more rain.



In 2080, the warmer oceans will thus generate climatic phenomena never before recorded, with violent winds and heavy rainfall. If the risks of particularly destructive tropical storms are higher, the data cannot however predict whether their frequency will increase or decrease, because many parameters are involved.



(left) Hurricanes today last longer than 50 years ago

Hurricanes today are penetrating further inland with higher intensities. (right)

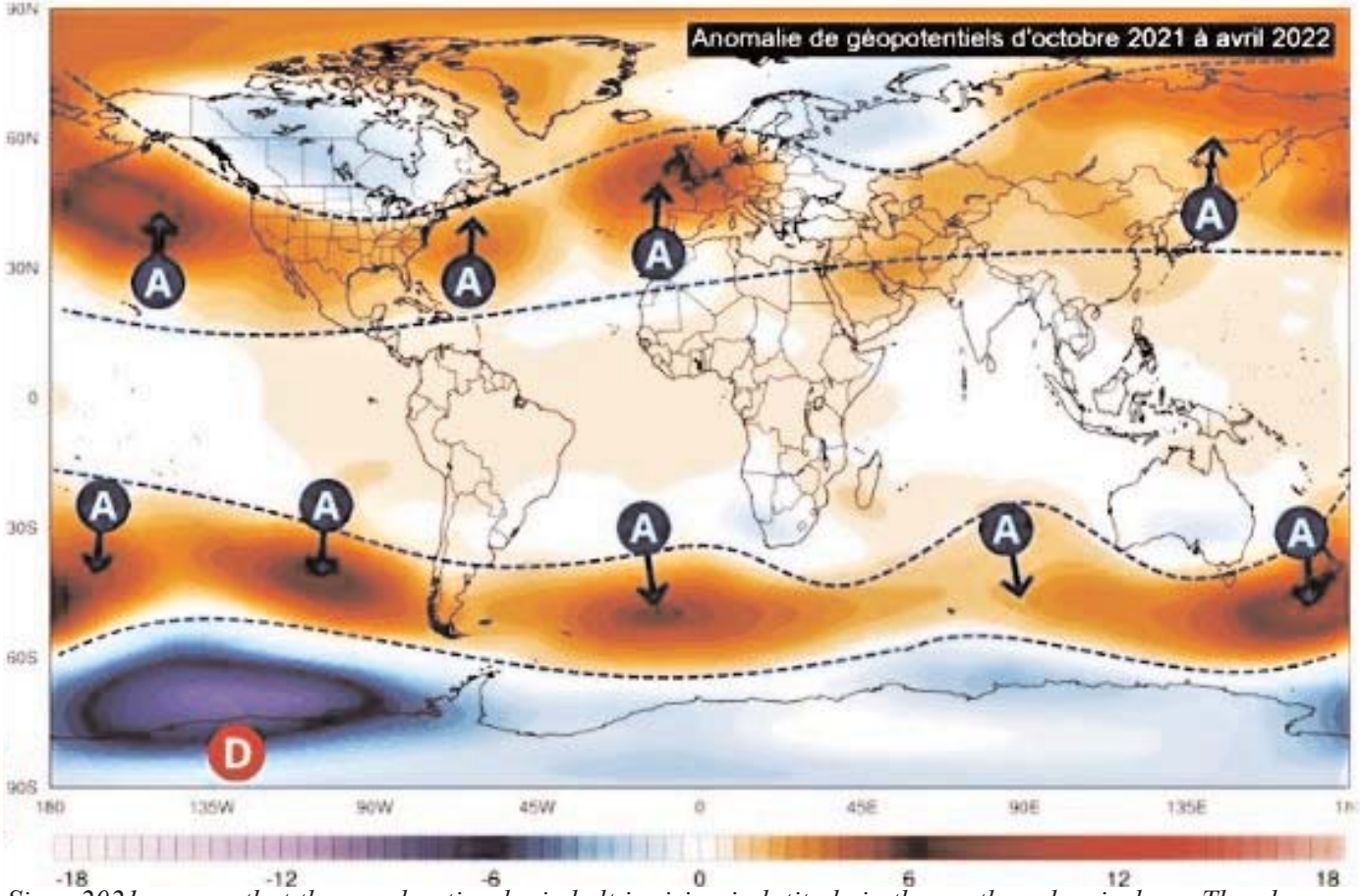
ANTICYCLONE

Anticyclonic blocking situations have been increasing for several years, resulting in early heat and worrying drought. Are anticyclones really not where they were in the past? Since the beginning of 2022, the observation has been clear: the rainfall deficit has reached -41% in January, -38% in February, -38% in March and -25% in April. The conditions in May follow the same scenario, with long hot and sunny periods. The average cumulative rainfall across the country is also the lowest in 11 years.

These weather blockages, as meteorologists call them, seem to be becoming more and more frequent. Has the Azores High decided to change its place of residence and settle permanently in our country?

According to meteorologist Guillaume Séchet, in his study published on Météo-Villes, "since autumn 2021, the recurrence of anticyclonic blockages over western Europe has reached remarkable levels", over the last eight months, from October 2021 to April 2022, we notice "a high pressure anomaly over all of western Europe, particularly over the British Isles, northern France and the North Sea. Such anomalies smoothed over an eight-month period are major and testify to an abnormal position of the anticyclone, to the detriment of the oceanic flow".

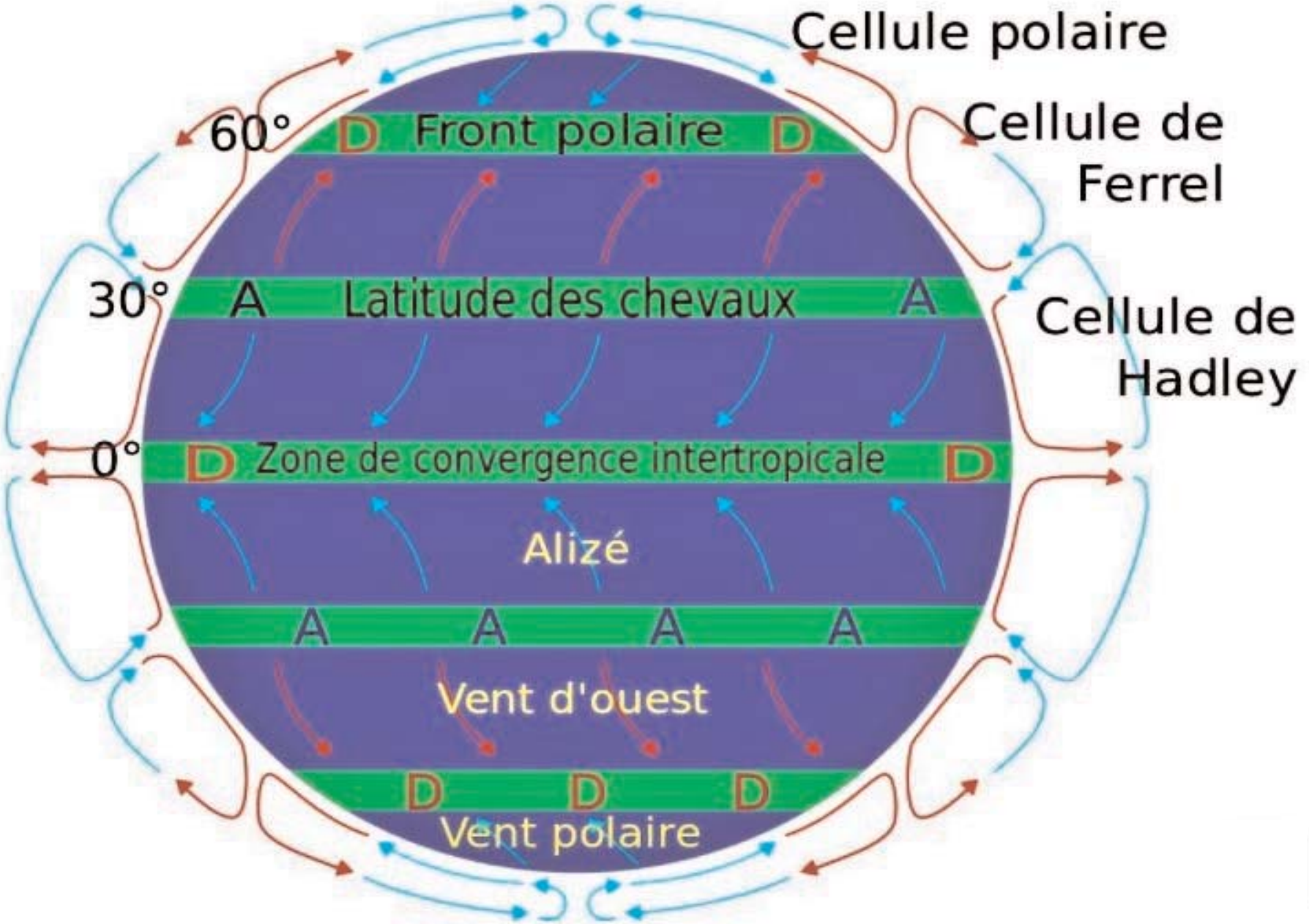
Disrupted atmospheric circulation?



Since 2021, we see that the usual anticyclonic belt is rising in latitude in the northern hemisphere. The observation is the same in the southern hemisphere where the high pressures are further south than normal...

The atmospheric circulation on Earth has several cells positioned at different latitudes. Hadley's cell is located between the equator and 30 degrees north and south latitude, where there are winds blowing from the northeast in the northern hemisphere and from the southeast in the southern one (the trade winds). Has atmospheric circulation really been disrupted in recent years due to global warming?

Concerning future projections, the modification of the atmospheric circulation, and therefore of the positioning of the anticyclones, is however very probable: "the climate models all agree on the fact that the Hadley cells will have a greater meridian extension in the future. , in connection with anticyclones which shift towards the poles, just like the rail of depressions.



Un schéma du globe montrant la position de la cellule de Hadley. © pinpin, wikipedia

Concerning future projections, the modification of the atmospheric circulation, and therefore of the positioning of the anticyclones, is however very probable: "the climate models all agree on the fact that the Hadley cells will have a greater meridian extension in the future. , in connection with anticyclones which shift towards the poles, just like the rail of depressions

Climate change: the uncertainties of the projections

What credit should be given to projections which, for the coming century, range from 1 to 6 degrees of average warming? Very wide range, too wide, but it must be understood that each of these projections results:

(i) an emissions scenario dependent on assumptions about political and economic decisions, development and technological change;
(ii) the estimation of the evolution and geographical distribution of disturbances of energy flows (radiative forcing) caused by these emissions, evolution which depends on the complex physico-chemistry of clouds and aerosols, CO2 exchanges and other gases between the atmosphere, biosphere and oceans, the disturbance of the optical properties of clouds, the transport of atmospheric particles (aerosols) and their leaching by precipitation;
(iii) the calculation of the response of the atmosphere and the ocean, i.e. the statistics of the set of changes in temperature, humidity, precipitation, cloudiness, winds and currents that these disturbances.

The extreme projection of 6 degrees of warming comes from a relatively sensitive climate model, coupled with a scenario in which the increase in emissions of CO2 and other greenhouse gases continues at an accelerated rate, while the generalization anti-pollution measures lead to a reduction in SO2 emissions. The scenarios studied before 1990 included rigorous numerical experiments where only one thing was changed at a time ¾ CO2 -- without modifying the production of particles by sulfur pollution. In some of the more recent projections, with less clean but more realistic scenarios, the strengthening of the parasol effect partly offsets the intensification of the greenhouse effect, hence less warming. The sensitivity of the climate model has not necessarily changed. Making fun of models without trying to understand and explain the nature of simulations is also part of a certain pseudo-scientific if not frankly anti-scientific discourse.

What is too often overlooked is that climate models are not mere "extrapolations"; they are the digitization of the fundamental laws of physics ¾ Newton's laws, principles of conservation of energy and matter, applied to our planet. The uncertainties in the calculation of climate change come from the need to schematize, to represent the complexity of the Earth with a relatively small number of parameters on a grid whose cells are typically a hundred kilometers across, one kilometer thick, to represent by a few simple relations what is happening inside each cell. Cloud and water vapor feedbacks depend on both planetary scale water transport and microscale condensation processes, which are difficult to represent together in a single model.

The big risk - a climate shock

Due to its rapidity, the warming of the 21st century could nevertheless severely test the adaptive capacities of the natural biosphere and of human societies. With a new precipitation and evaporation map, the forests will have to move; they were able to do so over the millennia following the retreat of the ice, but in less than a century, man will have to take charge of them. Farmers will have to adapt to the new sharing of water, insurers calculate the new risk map, cities take care of their water supply, more difficult here, easier there. This will be no small matter, and if one argues that Life has always known how to adapt or recover from catastrophes, that is cold consolation for the dinosaurs of the Cretaceous, for the Vikings of Greenland.

Atmospheric alteration and economic activity

Today, annual CO2 emissions per capita range from 20 tons in the United States and 9 for the European Union to less than 2 tons in the United States and 9 for the European Union to less than 2 for the countries of the Third World. Contrary to what one sometimes reads, the problem is not mainly in the growth of populations in the Third World.

Poor countries with very high population growth tend to remain poor, to have the lowest rates of development and CO2 emissions; countries with strong economic growth, such as China, are in the process of controlling their demography. Will they follow the model of all-out waste? But who wastes the most?

So far, the only countries that have substantially reduced their greenhouse gas emissions are those of the former Soviet bloc, following their economic collapse. This is not encouraging, but we must not confuse cause and effect. Moreover, if instead of quoting CO2 emissions per capita, we examine emissions in terms of the production of goods, we find that where the American-Australian world emits roughly one tonne of CO2 per thousand dollars (or euros) of gross domestic product, Japan and Western European countries emit only between 300 and 600 kg of CO2 to produce the same quantity of goods. Despite some recent progress, the countries of the former Soviet bloc emit around 2 tons or more of CO2 (and much more before 1990), thus using fossil energy even more poorly than America and Australia. China also emits well over a ton of CO2 to produce a thousand dollars of goods, but with its economic development this ratio of inefficiency decreases, and China seems to be able to get richer without necessarily increasing its CO2 emissions per capita.

We must initiate and accelerate this process, learn to do more and better with less, everywhere in the world.

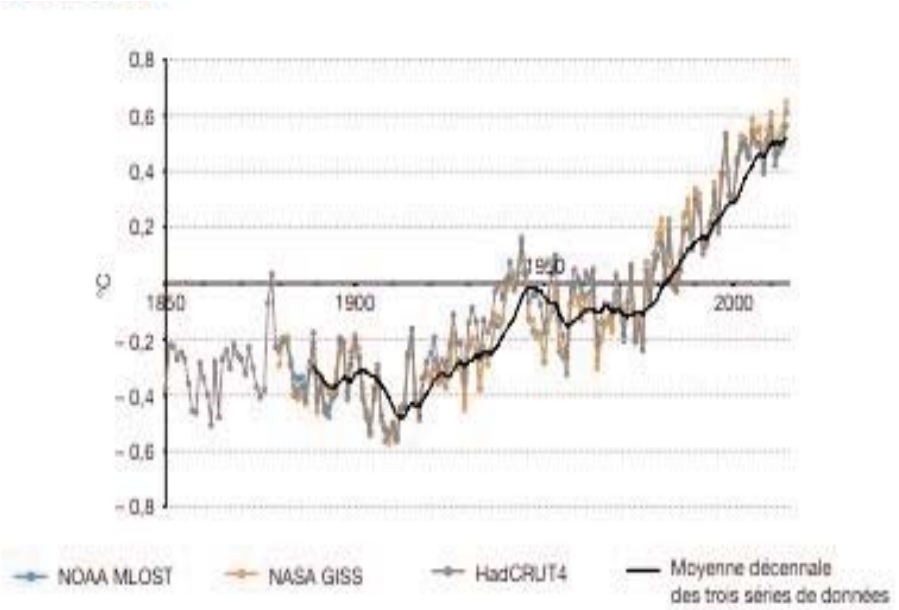
What if the climate changes? It won't be the end of the world. Earth has seen others. But for us humans? The imminent flooding of all the coastal plains, a bogeyman? 3000 years from now, who knows? In any case, even a modest rise in the sea (60 cm by 2100?) will increase the risks associated with surges during the passage of storms and cyclones. We will complain about the heat, we will die less of cold. Here, the drought; there, the deluge. Storms will change their tracks, becoming more violent here, less frequent there. Should we scare ourselves by evoking the specter of an extension of "tropical" diseases? Without any particular qualifications to talk about health, I cannot help but think that climate risk is only a small part of the problem. Europe and North America experienced malaria and major cholera pandemics in the 19th century when it was colder.

Today, air transport makes short work of disease-carrying mosquitoes, and in cities, even without climate change, there is hardly a shortage of warm places to spend the winter. It seems to me that the major health problems of the coming decades, which already affect tens of millions of people or more, will not be due to the climate: AIDS in Africa and elsewhere, and in Bangladesh the progressive poisoning of the population by arsenic of natural origin contained in "clean" water pumped from a few tens of meters deep.

The question remains: will we be able to use the possibilities of modern technologies (not only nuclear power) to improve the standard of living in the world without accelerating the alteration of the atmosphere and global warming? More difficult: when will we be able to reduce net greenhouse gas emissions to zero?

Observations of climate change

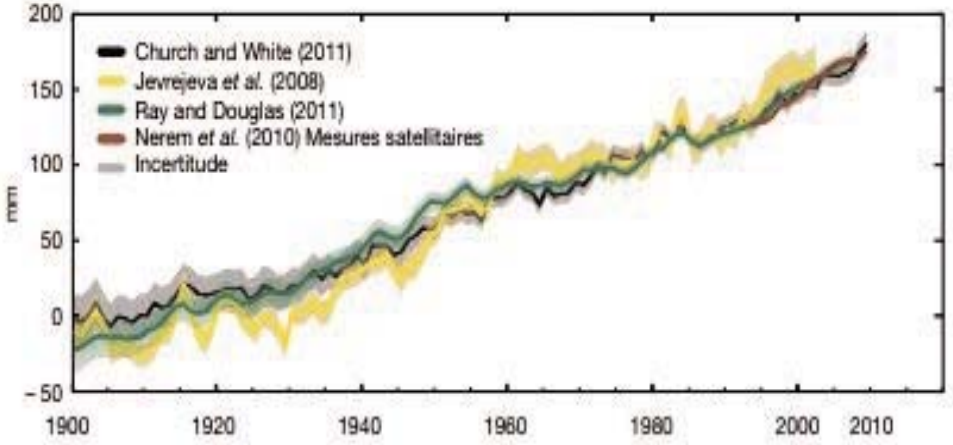
EVOLUTION OF THE GLOBAL ANNUAL MEAN TEMPERATURE



***Source :** NOAA, NASA, Hadley Center*

The warming of the global average temperature is very clear. The gap by compared to the average for the reference period 1961-1990 is strongly negative until 1940, then mostly negative until about 1980, then global warming widened and the gap has almost always been positive since the beginning of the 1980s. The decade 2001-2010 was warmer by 0.21°C than the decade 1991-2000 and is 0.48°C above the 1961-1990. The year 2015, with an average temperature 0.74°C higher than the average 1961-1990.

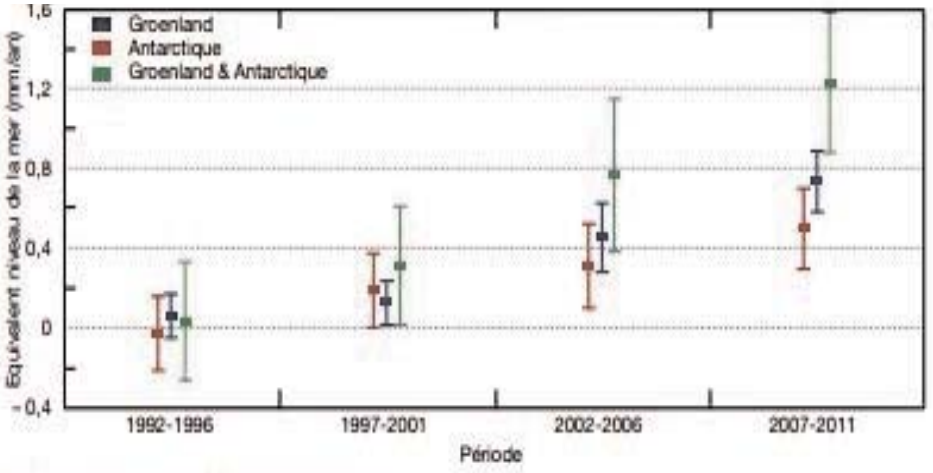
EVOLUTION OF THE MEAN LEVEL OF GLOBAL SEAS COMPARED TO THE REFERENCE PERIOD 1900-1905



***Source :** Giec, 1er groupe de travail, 2013*

Mean sea level rose by 1.7 ± 0.3 mm/year over the period 1901-2010. The rate of sea level rise has accelerated in recent decades to reach 3.2 ± 0.4 mm/year over the period 1993-2010 (satellite measurements).

MELTING ICE CAPS

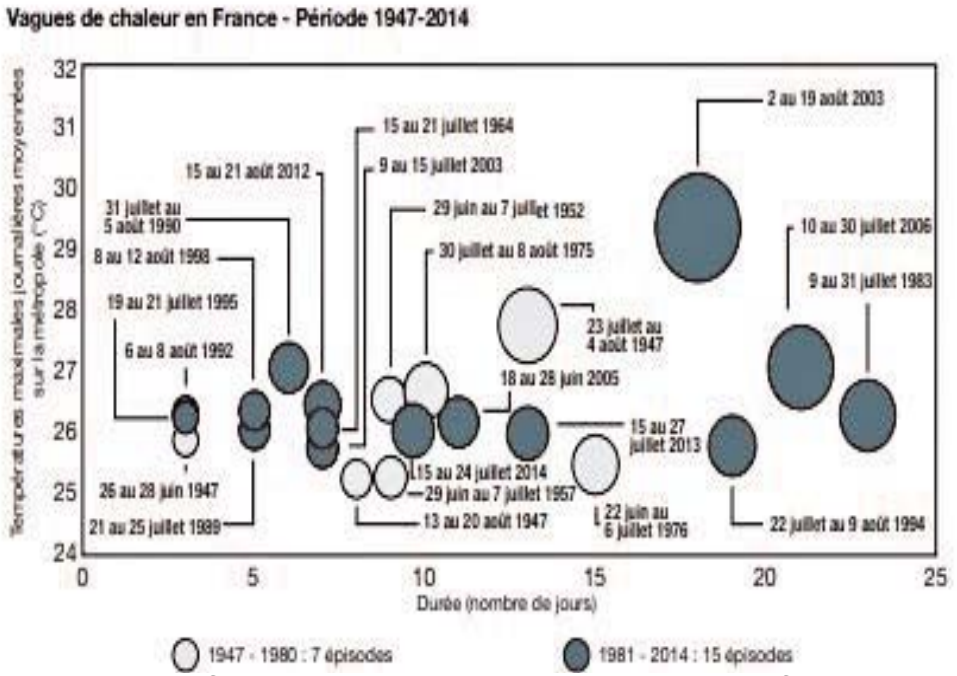


***Source :** Giec, 1er groupe de travail, 2013*

The total loss of continental polar ice over the 20-year period from 1992 to 2011 corresponds to a sea level rise of about 11.7 mm (8.4 to 15.1 mm). The greatest losses were observed over the last decade (2002-2012).

EXTREME CLIMATE EVENTS

A climatic event (cyclones, storms, heat waves, intense rainfall events, etc.) is said to be extreme when it greatly exceeds the reference levels. Climate change alters the frequency, intensity, extent, duration and timing of extreme weather and climate events. It can take these phenomena to unprecedented levels.

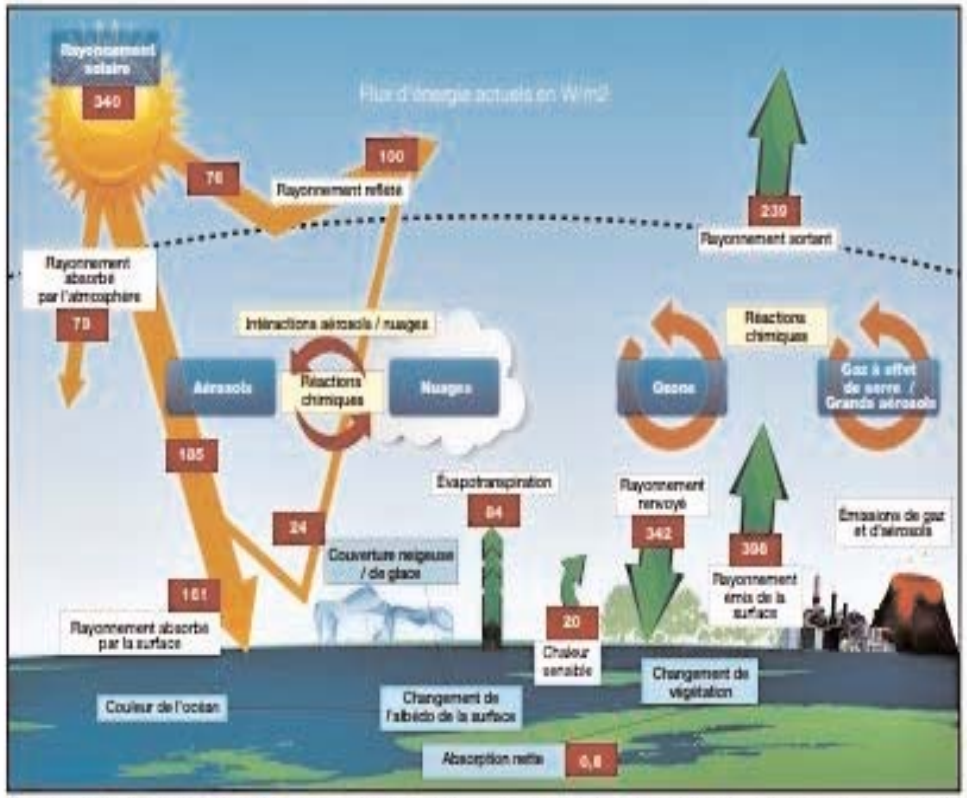

Vagues de chaleur en France - Période 1947-2014
Température maximales journalières moyennées sur la métropole (°C)
Durée (nombre de jours)
2 au 19 août 2003
15 au 21 juillet 1964
9 au 15 juillet 2003
15 au 21 août 2012
29 juin au 7 juillet 1952
31 juillet au 5 août 1990
30 juillet au 8 août 1975
10 au 30 juillet 2006
8 au 12 août 1998
9 au 31 juillet 1983
19 au 21 juillet 1995
23 juillet au 4 août 1947
6 au 8 août 1992
18 au 28 juin 2005
15 au 27 juillet 2013
15 au 24 juillet 2014
26 au 28 juin 1947
29 juin au 7 juillet 1957
22 juin au 6 juillet 1976
13 au 20 août 1947
21 au 25 juillet 1989
22 juillet au 9 août 1994
1947 - 1980 : 7 épisodes
1981 - 2014 : 15 épisodes

Note: the size of the discs is proportional to the intensity of the waves
Source: Meteo-France

Heat waves recorded since 1947 on a national scale have been twice as numerous over the past 34 years as over the previous period. This evolution is also materialized by the occurrence of stronger events (duration, overall intensity) in recent years. Thus, the 4 longest heat waves and 3 of the 4 most intense occurred after 1981. The heat wave observed in France from August 2 to 19, 2003 is by far the most significant event over the observation period.

Causes of climate change

THE NATURAL GREENHOUSE EFFECT AND ITS DISRUPTION BY HUMAN ACTIVITIES



The sun's rays provide energy to the Earth. Some of it is directly or indirectly reflected back into space, while the majority is absorbed by the atmosphere or the earth's surface. The relatively mild temperature at the Earth's surface is due to the presence of GHGs, which reflect the majority of surface radiation back to the ground.
Source: IPCC , 1st working group, 2013

The increase in the atmospheric concentration of GHGs by anthropogenic emissions increases the return of energy to the ground, leading to an imbalance in the system and causing the rise in the Earth's temperature. The change from a base year in the radiation induced by an element is called radiative forcing. A positive radiative forcing indicates a positive contribution to global warming. The total anthropogenic radiative forcing amounts to + 2.55 (± 1.1) W/m² in 2013 compared to 1750.

GREENHOUSE GASES (GHG)

Excluding water vapour, GHGs occupy less than 0.1% of atmospheric volume . Water vapour, which fluctuates between 0.4% and 4%, is the main GHG. Human activities have very little impact on fluctuations in its concentration but have a strong impact on the concentrations of other GHGs.

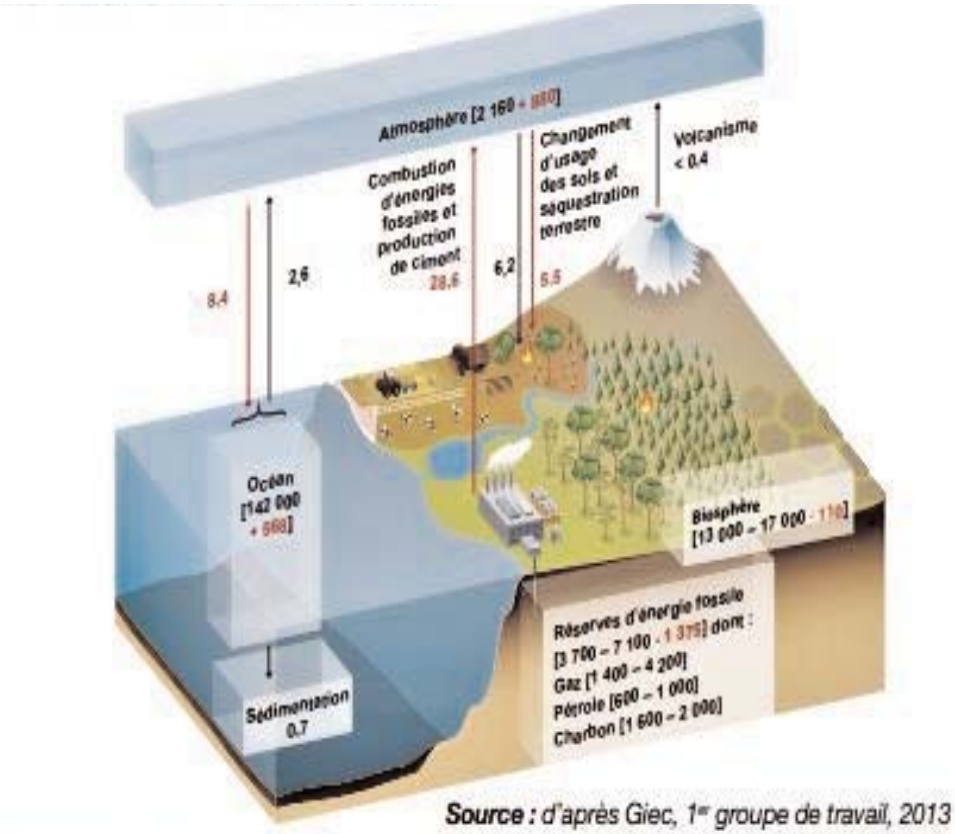
	CO_2	CH_4	N_2O	HFC	PFC	SF_6	NF_3
Concentration atmosphérique 2014 (en 2005 entre parentheses)	397 ppm (379 ppm)	1 823 ppb (1 774 ppb)	327 ppb (319 ppb)	> 157 ppt (> 49 ppt)	> 6,5 ppt (> 4,1 ppt)	8,2 ppt (5,6 ppt)	< 1 ppt
Pouvoir de Réchauffement Global (cumulé sur cent ans)	1	28-30	265	[1,4 ; 14 800]	[6 630 ; 11 100]	23 500	16 100
Origine des émissions anthropiques	Combustion d'énergie fossile, procédés industriels et déforestation tropicale	Décharges, agriculture, élevage et procédés industriels	Agriculture, procédés industriels, utilisation d'engrais	Sprays, réfrigération, procédés industriels			Fabrication de composants électroniques
Modification du forçage radiatif en 2014 depuis 1750 par les émissions anthropiques (W/m^2) (en 2005 entre parentheses)	+ 1,91 (+ 1,66)	+ 0,50 (+ 0,48)	+ 0,19 (+ 0,16)	+ 0,12 (+ 0,09)			

ppm = parts per million, ppb = parts per billion, ppt = parts per trillion.

Source : *Giec, 1er groupe de travail, 2013, NOAA (2016), Agage (2016)*

The global warming potential (GWP) is the ratio between the energy returned to the ground in 100 years by 1 kg of gas and that which would be returned by 1 kg of CO2. It depends on the concentrations and lifetimes of the gases. for example, 1 kg of CH4 will warm the atmosphere as much as 28 to 30 kg of CO2 during the century following their emission. If CO2 is the gas with the lowest global warming potential, it is the one that has contributed the most to global warming since 1750, due to the large quantities emitted.

CYCLE OF CO_2 DURING THE 2000 YEARS


Atmosphère [2 160 + 880]
Combustion d'énergies fossiles et production de ciment 28,6
Changement d'usage des sols et séquestration terrestre
Volcanisme < 0,4
8,4
2,6
6,2
5,5
Océan [142 000 + 668]
Biosphère [13 000 – 17 000 · 110]
Réserves d'énergie fossile [3 700 – 7 100 · 1 375] dont : Gaz [1 400 – 4 200] Pétrole [600 – 1 000] Charbon [1 600 – 2 000]
Sédimentation 0,7

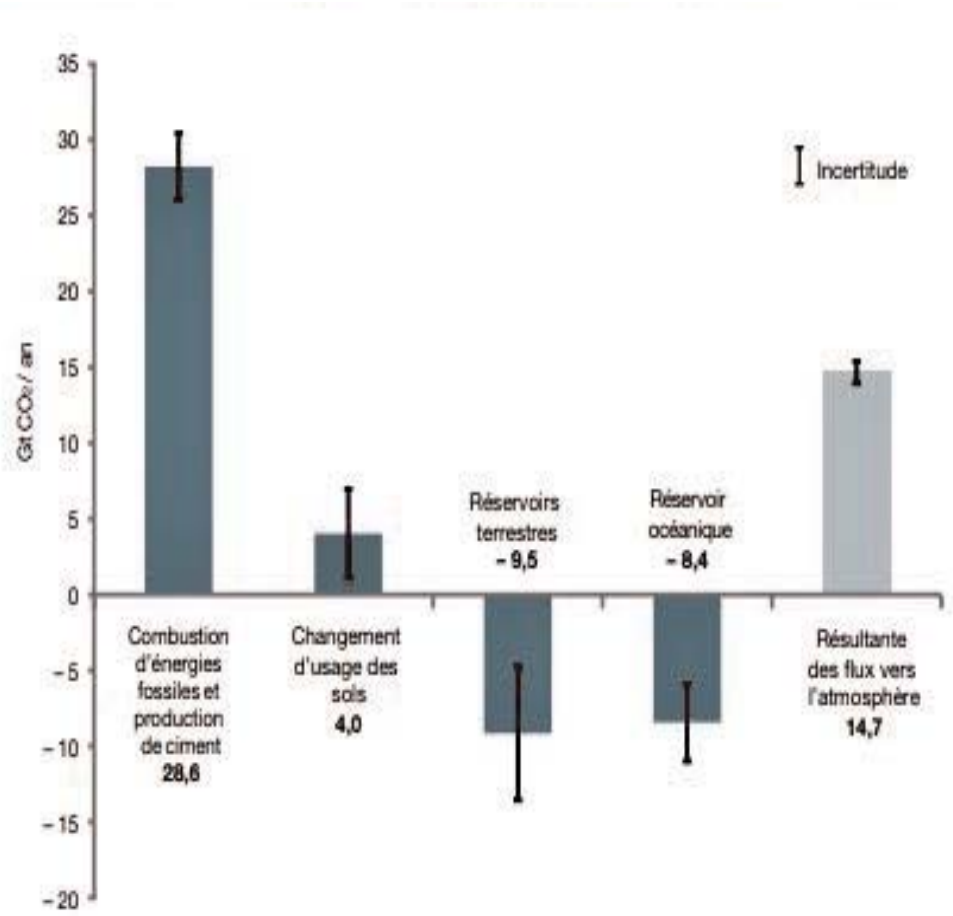
Source : *d'après Giec, 1er groupe de travail, 2013*

Four large reservoirs store carbon in different forms:
- atmosphere: CO2 gas;
- biosphere: organic matter from living beings including the forest;
- ocean: limestone, dissolved CO2;
- subsoil: rocks, sediments, fossil fuels.

The carbon fluxes between these reservoirs constitute the natural carbon cycle, disturbed by anthropogenic CO2 emissions which modify the flows exchanged or create new ones such as the combustion of organic carbon reserves fossil .

IMBALANCE BETWEEN EMISSIONS AND CO2 STORAGE CAPACITY

Net annual fluxes of CO2 to the atmosphere by source and by reservoir



Source : *Giec, 1er groupe de travail, 2013*

During the 2000s, of the 32.6 Gt of CO2 released on average per year by human activities, the atmosphere absorbed 14.7, the terrestrial reservoirs (biosphere and soils) 9.5 and the oceans 8 . ,4. The atmosphere is the reservoir most affected by anthropogenic activities: the quantity of carbon absorbed has increased by nearly 40% compared to the pre-industrial era.

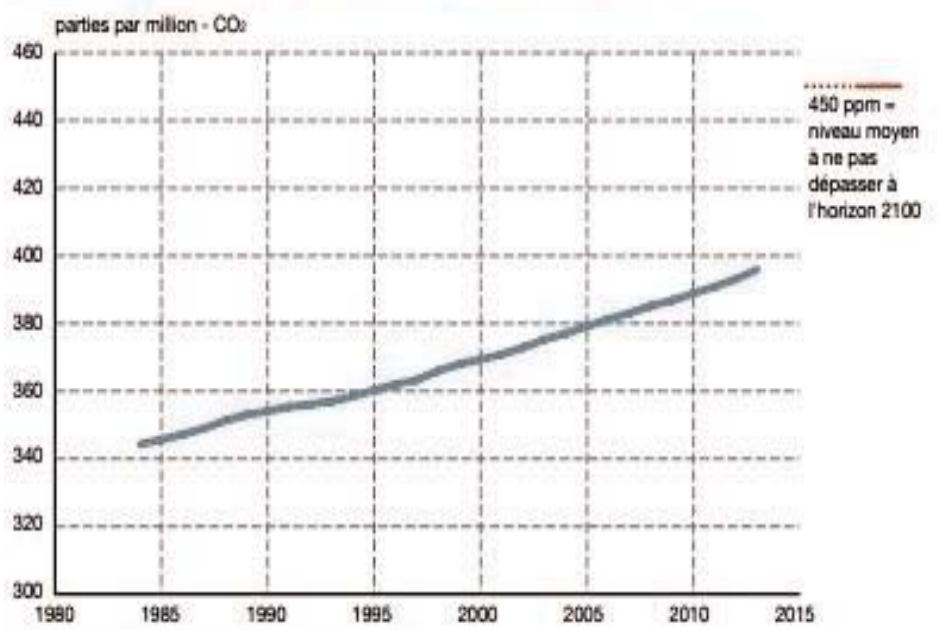
ROLE OF THE FOREST IN THE CO_2 CYCLE

The forest is the most important terrestrial store of carbon. It sequesters 9.2 Gt of net CO2 emissions per year, the equivalent of 33% of global GHG emissions.

Deforestation results in GHG emissions through the combustion and breakdown of organic matter. These gross emissions represent approximately 11% of the annual anthropogenic sources of GHGs in the world (source: Van der Werf and co-authors, 2009, Nature Geoscience) .

In France, net carbon sequestration in forest biomass is estimated at around 70 Mt CO2, or 15% of national fossil carbon emissions (Citepa , 2016) .

ATMOSPHERIC CO_2 CONCENTRATION

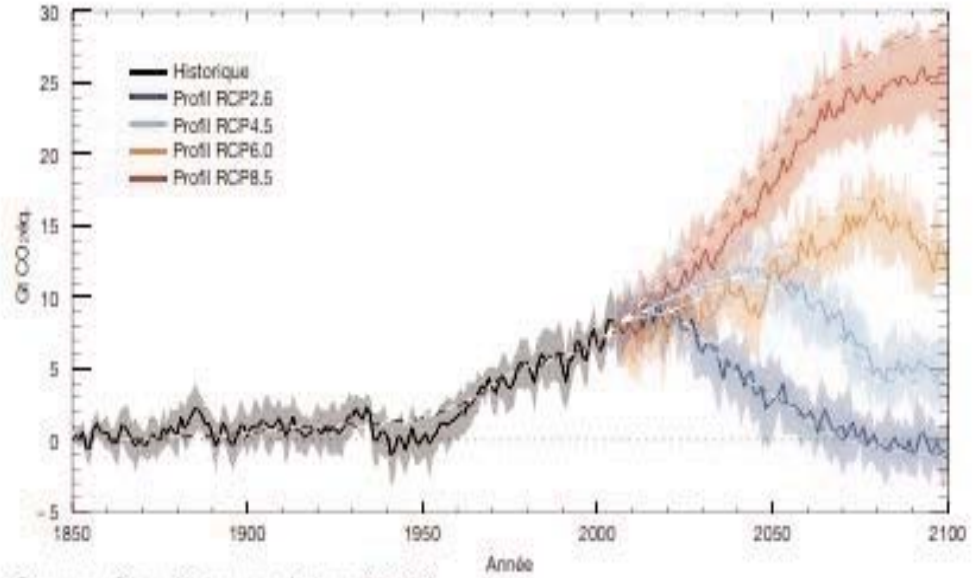


Source : *CMDGS sous l'égide de l'OMM*

Since the development of industrial activities, terrestrial and oceanic reservoirs have absorbed half of anthropogenic emissions. The remaining emissions persist in the atmosphere, leading to increased concentrations of GHGs.

Climate scenarios and projections

PROJECTIONS OF FOSSIL FUEL EMISSIONS ACCORDING TO THE FOUR GHG TREND PATTERNS (IPCC RCP)



Source : *Giec, 1er groupe de travail, 2013*

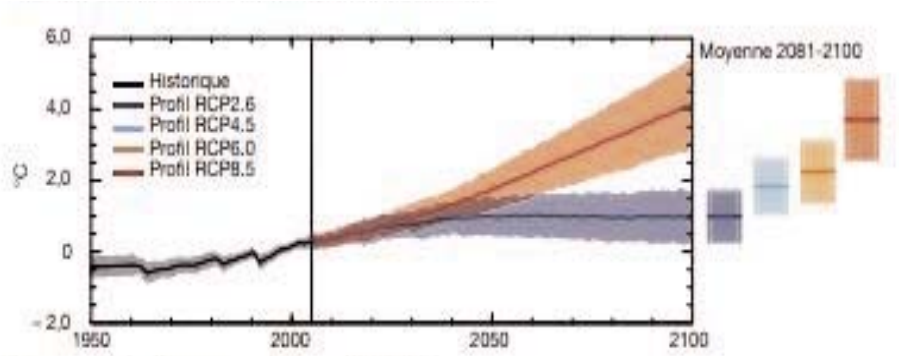
The IPCC published its first report (First Assessment Report) in 1990. Its fifth report (AR5) was published in its entirety at the end of 2014. With each publication, the IPCC communicates climate projections based on GHG concentration hypotheses.

For AR5, four GHG concentration evolution profiles (RCP, for Representative Concentration Pathways) have been defined: RCP2.6; RCP4.5; RCP6.0; RCP8.5, from the most optimistic to the most pessimistic, named according to the value of the radiative forcing induced at the horizon 2100 (RCP8.5 thus corresponds to a situation where the radiative forcing at the horizon 2100 amounts to 8, 5W/m².)

These profiles correspond to greater or lesser efforts to reduce GHG emissions at the global level. From these, climate simulations and socio-economic scenarios were developed.

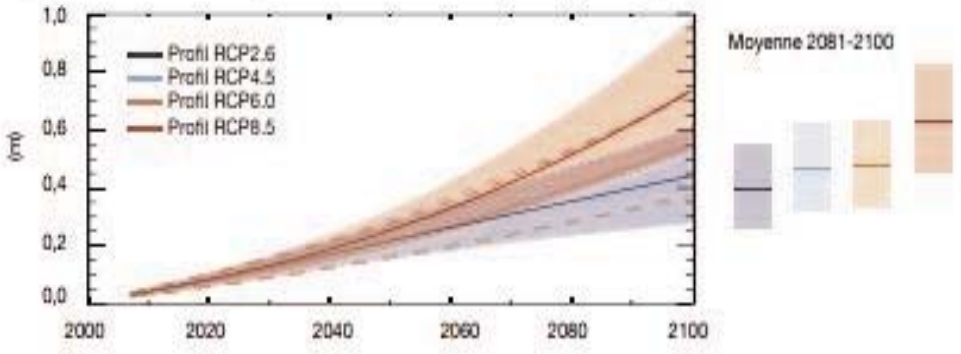
EVOLUTION OF TEMPERATURES AND SEA LEVELS FOLLOWING THE IPCC CONCENTRATION EVOLUTION PROFILES

Projection of mean temperature variation



Source : *Giec, 1er groupe de travail, 2013*

Projection of average sea level rise relative to the period 1986-2005



Source : *Giec, 1er groupe de travail, 2013*

The main factors of sea level rise are the thermal expansion of the oceans and the melting of terrestrial ice reservoirs (glaciers, polar ice caps, etc.).

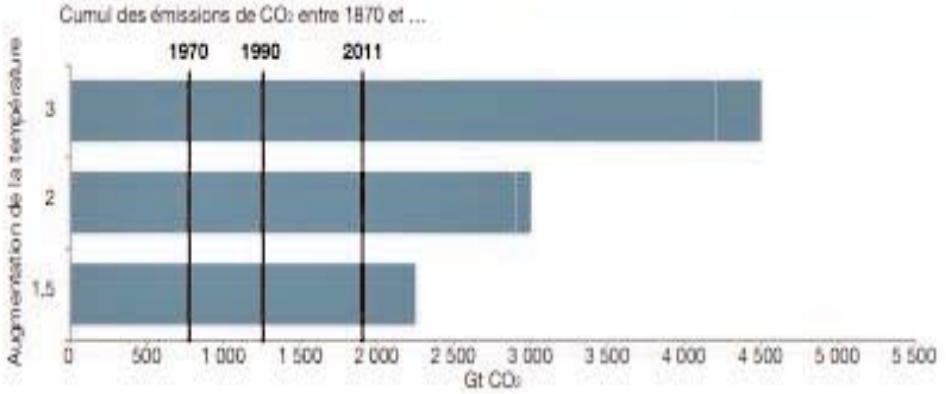
Rising sea levels are likely to cause large population migrations, since more than a billion people live in coastal lowlands.

Despite many advances in recent years, ice melt forecasting models still have large margins of uncertainty.

CARBON BUDGETS AND RISE IN TEMPERATURE

IPCC temperature change profiles , only the most ambitious, RCP 2.6, gives a probability greater than 50% of limiting the temperature rise to 2°C by 2100. Among the 4 main profiles of he evolution, RCP 8.5, has

Budget carbone correspondant à la limite d'augmentation de température avec une probabilité de 50 %



Note: the graph reads as follows: with a probability of 50%, a temperature increase of less than 3°C by 2100 implies the cumulative emission of less than 4,500 Gt CO2. Among the GHGs, only CO2 is taken into account here.

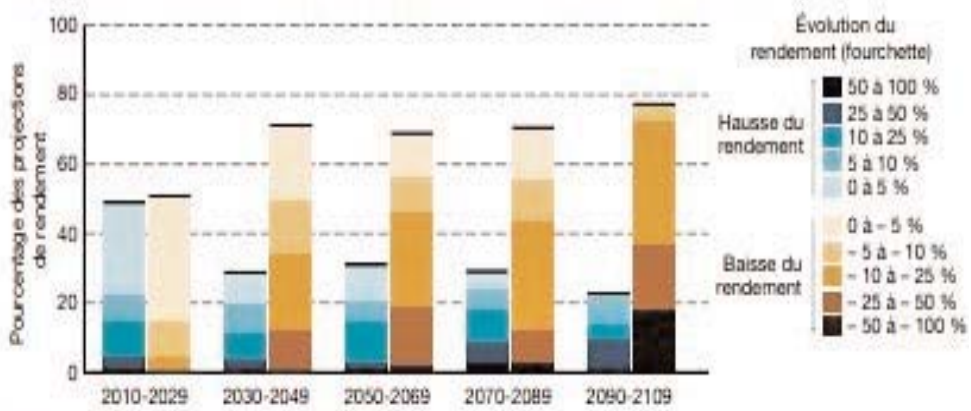
***Source :** I4CE, à partir de Giec, 1er et 3e groupes de travail, 2014*

A carbon budget corresponds to a maximum quantity of GHG emissions to avoid too high a level of temperature increase.

IPCC simulations indicate that to have a 50% probability of remaining below 2°C by 2100, cumulative anthropogenic emissions since 1870 must not exceed 3,000 Gt CO2. However, between 1870 and 2011, humanity has already emitted 1,700 Gt CO2, the carbon budget consistent with the 2°C limit is therefore 1,300 Gt CO2 from 2011 until the end of this century. This carbon budget corresponds to about thirty years of emissions at the 2014 rate. limit of 2°C.

IMPLICATIONS FOR THE WORLD

Summary of expected changes in crop yield due to climate change during the 21st century compared to late 20th century levels

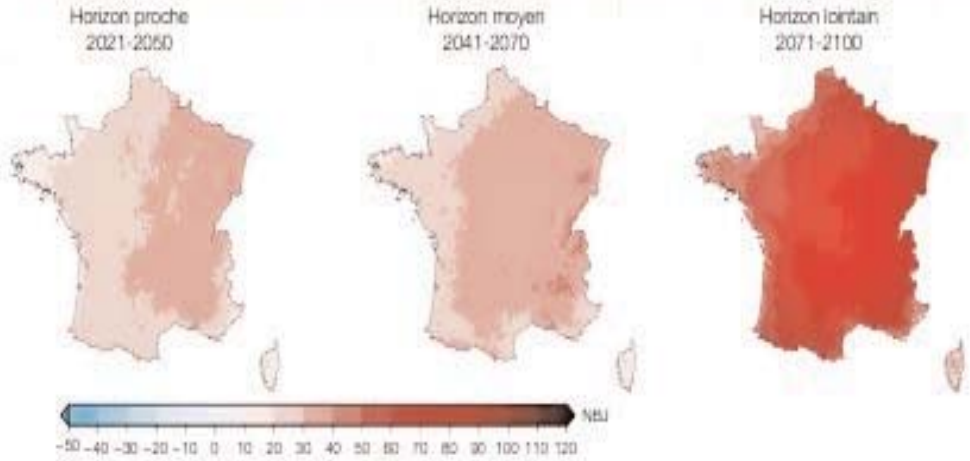


Change in yield (range) Decline in yield Rise in yield

Climate change, in the absence of adaptation, is expected to negatively affect the production of major crops (wheat, rice, maize and soybeans) in tropical and temperate regions. The probability of a negative impact on yields increases with time and the intensity of global warming. After 2050, this drop in average yields should be accompanied by a gradual increase in the interannual variability of yields in several regions.

CONSEQUENCES FOR FRANCE

Number of additional abnormally hot days in the future (IPCC RCP 4.5 scenario ,

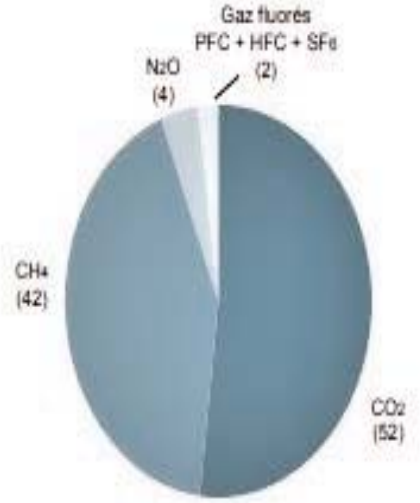


***Source :** Drias les futurs du climat. 2014*

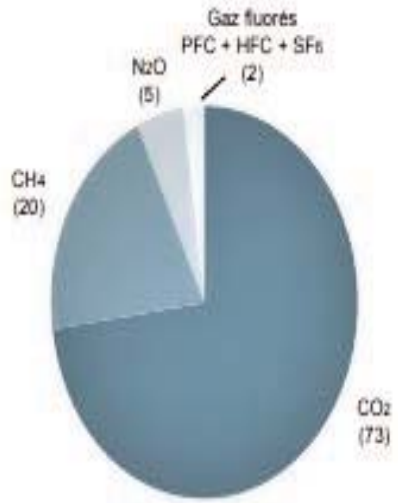
Global overview of GHG emissions

BREAKDOWN OF GLOBAL GHG EMISSIONS (INCLUDING LULUCF) BY GAS IN 2010
In %

According to the global warming potential at 20 years



According to the global warming potential at 100 years

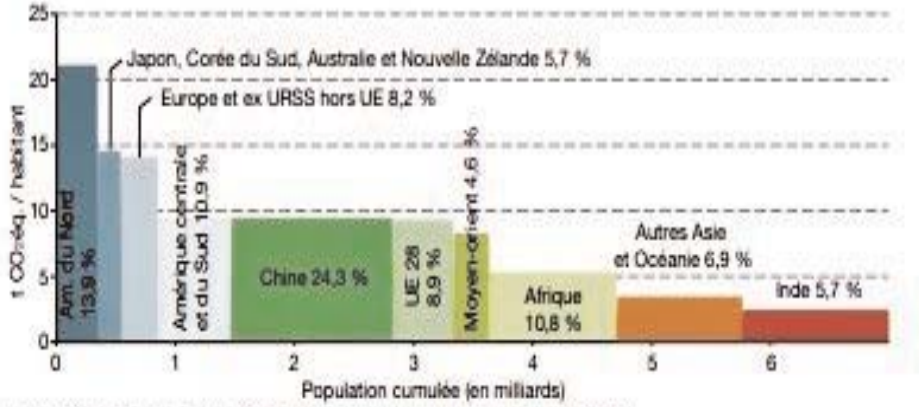


Source : *d'après Giec, 3e groupe de travail, 2014*

CO_2 : dioxyde de carbone ;
N_2O : protoxyde d'azote ;
CH_4 : méthane ; HFC : hydrofluorocarbures ;
PFC : perfluorocarbures ;
SF_6 : hexafluorure de soufre

Emissions of the six greenhouse gases initially covered by the Kyoto Protocol have increased by more than 80% since 1970 and 45% since 1990 to reach 54 Gt CO2eq. in 2013 against 49 Gt CO2eq. in 2010.

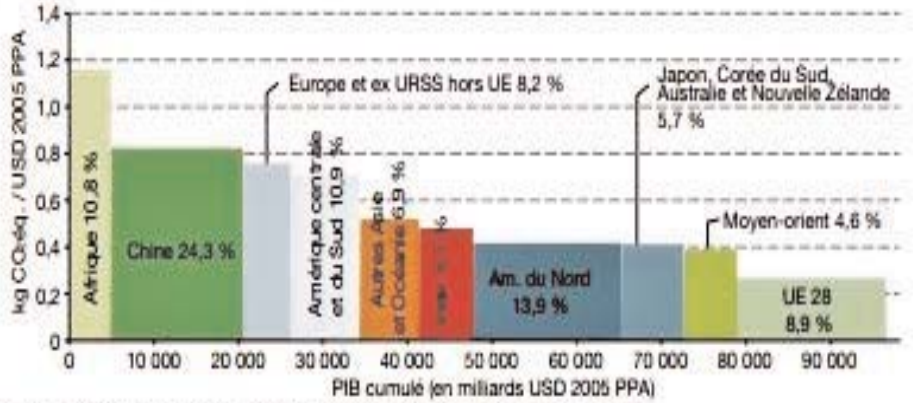
REGIONAL DISTRIBUTION OF GHG EMISSIONS (INCLUDING LULUCF) PER CAPITA IN 2012


t CO2eq. / habitant
Japon, Corée du Sud, Australie et Nouvelle Zélande 5,7 %
Europe et ex URSS hors UE 8,2 %
Am. du Nord 13,9 %
Amérique centrale et du Sud 10,9 %
Chine 24,3 %
UE 28 8,9 %
Moyen-orient 4,6 %
Afrique 10,8 %
Autres Asie et Océanie 6,9 %
Inde 5,7 %
Population cumulée (en milliards)

Source : *I4CE à partir de JRC EDGAR et Banque mondiale, 2015*

In 2012, average emissions per capita in North America are more than eight times higher than in India. Moreover, these values do not reflect the disparities that may exist in a geographical area (for example, in the Middle East, emissions per capita are more than 50 t CO2 eq./capita in Qatar and less than 2 t CO2eq./capita in Yemen), or within the same country

REGIONAL DISTRIBUTION OF GHG EMISSIONS (INCLUDING LULUCF) PER UNIT OF GDP IN 2012

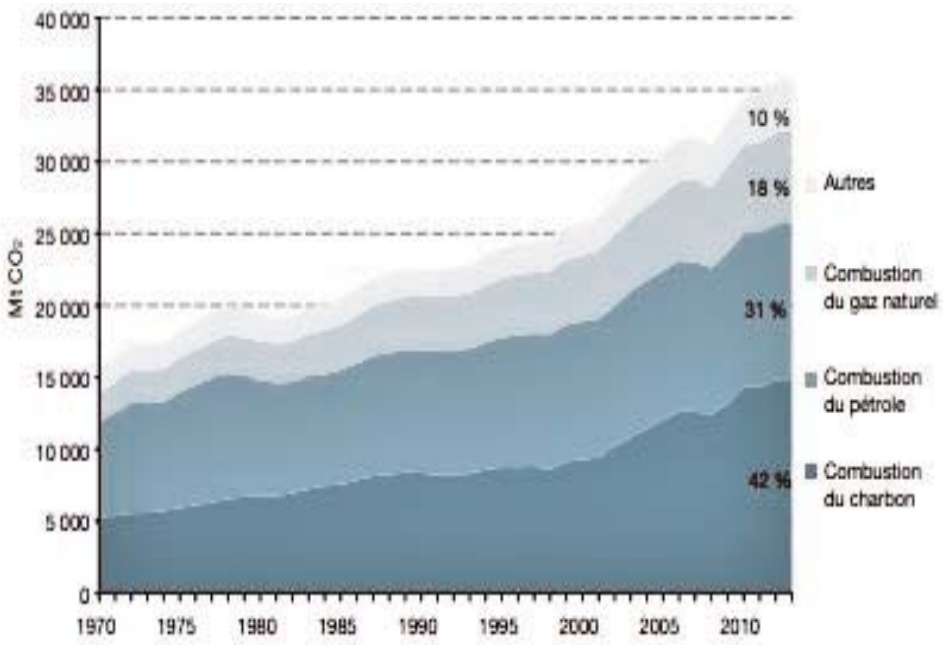

kg CO2eq. / USD 2005 PPA
Afrique 10,8 %
Chine 24,3 %
Europe et ex URSS hors UE 8,2 %
Amérique centrale et du Sud 10,9 %
Autres Asie et Océanie 6,9 %
Am. du Nord 13,9 %
Japon, Corée du Sud, Australie et Nouvelle Zélande 5,7 %
Moyen-orient 4,6 %
UE 28 8,9 %
PIB cumulé (en milliards USD 2005 PPA)

Source : *I4CE à partir de JRC EDGAR et Banque mondiale, 2015*

In 2012, the carbon intensity of GDP (GHG emissions divided by GDP) is more than four times higher in Africa than in the EU, which means that four times more GHGs are emitted there per unit of wealth produced .

Global overview of GHG emissions

CO2 EMISSIONS PER FUEL WORLDWIDE

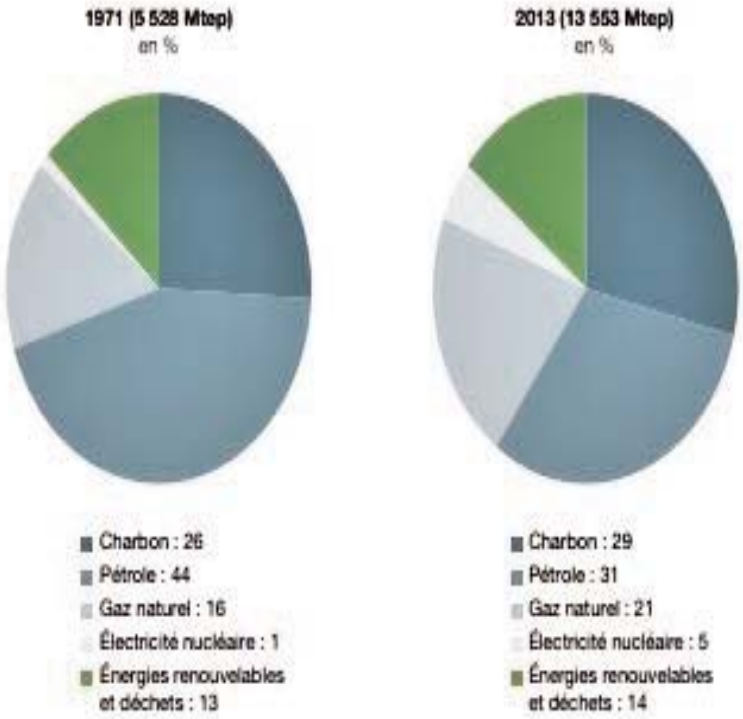


Note: the emissions counted here are those related to the combustion of fossil fuels and industrial processes. This corresponds to total CO2 emissions excluding LULUCF. They represent nearly 85% of CO2 emissions worldwide, or 65% of GHG emissions.

Source: EDGAR, 2015

In 2014, global CO2 emissions excluding LULUCF reached 35.7 billion tonnes. Nearly 42% of these emissions are linked to the combustion of coal, compared to 31% for oil and 18% for natural gas. As for emissions related to industrial processes such as cement manufacturing (excluding energy combustion), they represent 10% of the total

PRIMARY ENERGY MIX IN THE WORLD



Source : *AIE, septembre 2015*

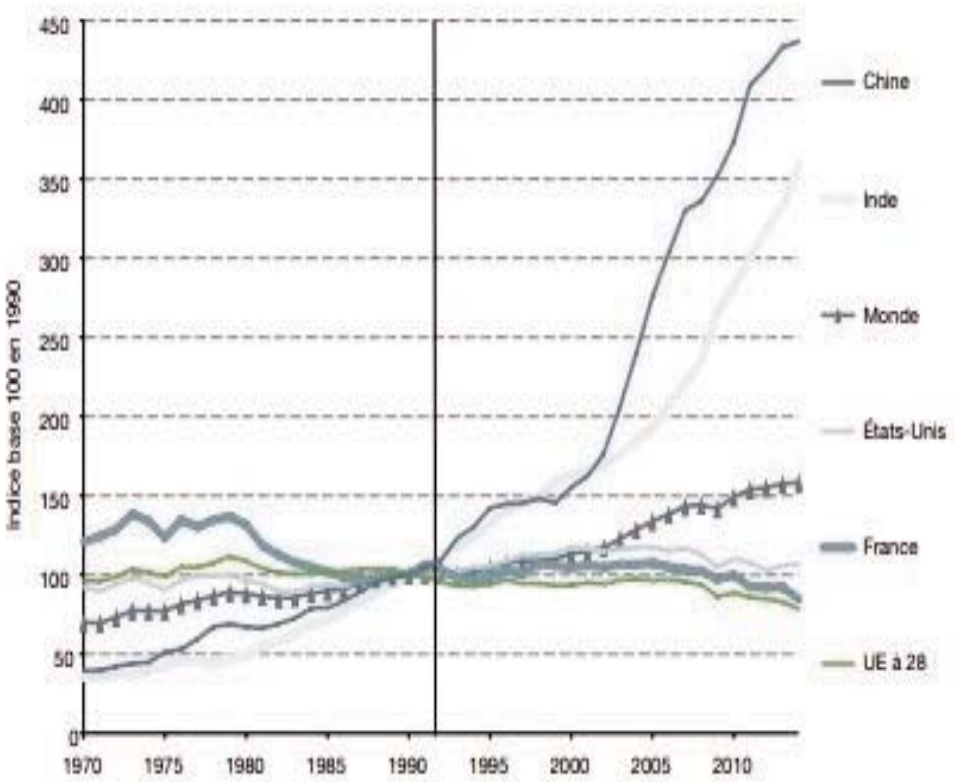
The breakdown of emissions should be compared to the global primary energy mix which, in 2013, was still 81% dominated by fossil fuels (coal, natural gas and oil). Since 1971, the share of oil in this mix has fallen by thirteen points to the benefit of gas (+5 points), nuclear electricity (+4 points) and coal (+3 points). Second source of energy after oil, with 29% of the mix, coal has an emission factor significantly higher than those of gas and oil and thus occupies first place in terms of CO2 emissions. As the production of renewable energies has increased at a rate close to total production, their share in the global energy mix, around 14%, has changed little in forty years.

INTERNATIONAL COMPARISON OF CO_2 EMISSIONS DUE TO ENERGY COMBUSTION ACCORDING TO THE APPROACHES

En Mt CO_2	1990	2013	2014	Part 2014 (%)	Évolution (%) 2014/2013	Évolution (%) 2014/1990
Amérique du Nord	**5 726**	**6 315**	**6 357**	**17,8**	**+ 0,7**	**+ 11,0**
dont : Canada	448	565	566	1,6	+ 0,2	+ 26,2
États-Unis	4 988	5 286	5 335	15,0	+ 0,9	+ 6,9
Amérique Centrale et du Sud	**647**	**1 291**	**1 306**	**3,7**	**+ 1,1**	**+ 101,8**
dont : Brésil	217	485	501	1,4	+ 3,3	+ 130,5
Europe et ex-URSS	**8 353**	**6 403**	**6 142**	**17,2**	**- 4,1**	**- 26,5**
dont : Russie	2 379	1 792	1 766	5,0	- 1,4	- 25,7
UE à 28	4 345	3 608	3 415	9,6	- 5,4	- 21,4
dont : UE à 15	3 282	2 888	2 711	7,6	- 6,1	- 17,4
Allemagne	1 008	813	767	2,2	- 5,6	- 23,9
Espagne	227	244	242	0,7	- 1,0	+ 6,5
France	387	353	324	0,9	- 8,3	- 16,3
Italie	424	366	338	0,9	- 7,6	- 20,4
Royaume-Uni	579	456	415	1,2	- 8,9	- 28,3
13 nouveaux États membres	1 063	720	704	2,0	- 2,3	- 33,8
Afrique	**667**	**1 162**	**1 188**	**3,3**	**+ 2,3**	**+ 78,1**
Moyen-Orient	**814**	**2 193**	**2 272**	**6,4**	**+ 3,6**	**+ 179,1**
dont Arabie Saoudite	168	483	495	1,4	+ 7,0	+ 194,3
Asie	**5 378**	**16 543**	**16 833**	**47,2**	**+ 1,8**	**+ 213,0**
dont : Chine	2 411	10 448	10 541	29,6	+ 0,9	+ 337,1
Corée du Sud	268	609	610	1,7	+ 0,2	+ 127,6
Inde	662	2 172	2 342	6,6	+ 7,8	+ 258,9
Japon	1 170	1 217	1 235	3,5	+ 1,5	+ 5,6
Océanie	**304**	**461**	**454**	**1,3**	**- 1,6**	**+ 49,4**
Pays de l'annexe I	**14 894**	**13 937**	**13 666**	**38,3**	**- 1,9**	**- 8,2**
Pays hors de l'annexe I	**6 995**	**20 431**	**20 886**	**58,6**	**+ 2,2**	**+ 198,6**
Soutes internationales	**626**	**1 109**	**1 117**	**3,1**	**+ 0,7**	**+ 78,2**
Monde	**22 516**	**35 477**	**35 666**	**100,0**	**+ 0,5**	**+ 58,4**

Between 1990 and 2013, CO2 emissions related to the combustion of energy in the OECD increased by 5% according to the territory approach, and by 9% according to the footprint approach. Over this period, they decreased by 18% in the EU 28 according to the territory approach and only by 14% according to the footprint approach. They have almost tripled in China, whatever the approach. Over this period, they decreased by 18% in the EU 28 according to the territory approach and only by 14% according to the footprint approach. They have almost tripled in China, whatever the approach. Emissions per capita in China are now equivalent to those in the EU 28, according to the territory approach. On the other hand, according to the footprint approach, emissions per capita are 30% lower in China than in the EU 28 (and more than 50% lower than the OECD average).

INTERNATIONAL EMISSIONS OF CO2 BETWEEN 1970 - 2014



Source : *SOeS d'après EDGAR, World Bank, 2015*

In 2014, nearly 30% of global emissions fell to China, the leading emitting country ahead of the United States (15.0%), the EU-28 (9.6% of the global total if the EU is considered as a whole) and India (6.6%). Between 1990 and 2014, global CO2 emissions increased by 58%. Among the main emitters, China posted the strongest growth: emissions multiplied by more than 4 over the period. As for the United States, their CO2 emissions have increased by 7% since 1990. Compared to 1990, the emissions of the EU of 28 have decreased by 21%, those of France by 16%.

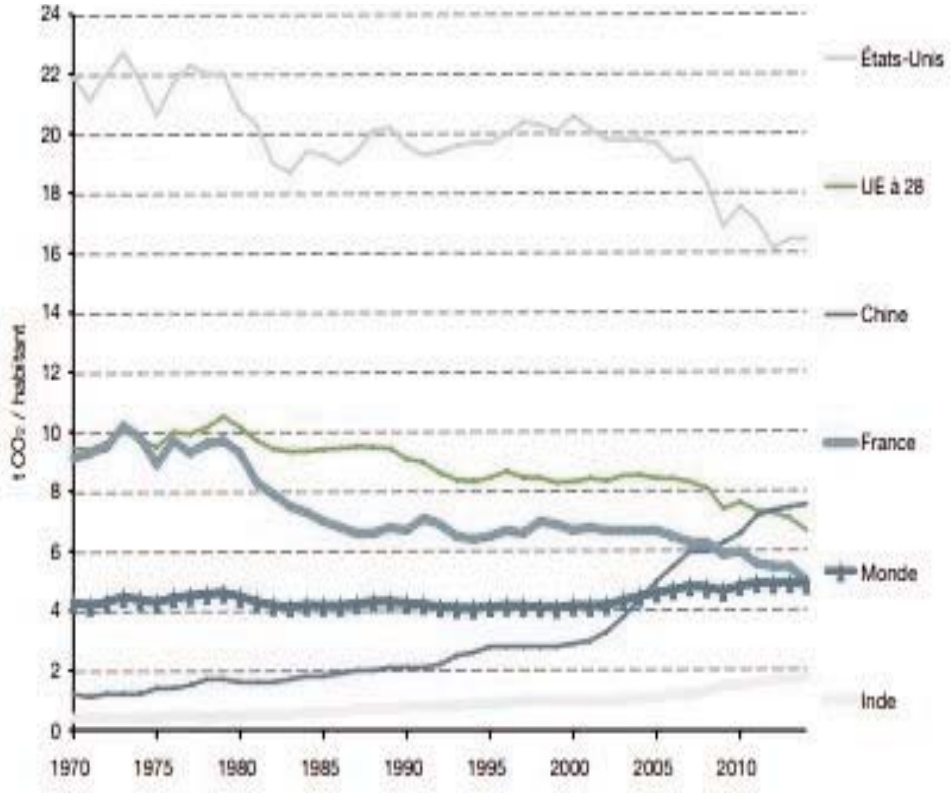
CO2 EMISSIONS PER CAPITA WORLDWIDE (EXCLUDING LULUCF)

En t CO_2 / habitant	1990	2013	2014	Évolution (%) 2014/2013	Évolution (%) 2014/1990
Amérique du Nord	**15,8**	**13,3**	**13,2**	**- 0,3**	**- 16,0**
dont : Canada	16,2	16,1	15,9	- 1,2	- 1,9
États-Unis	19,6	16,5	16,5	-	- 15,8
Amérique Centrale et du Sud	**1,8**	**2,6**	**2,6**	**+ 0,1**	**+ 45,2**
dont : Brésil	1,5	2,4	2,5	+ 2,5	+ 71,0
Europe et ex-URSS	**9,9**	**7,1**	**6,8**	**- 4,5**	**- 31,4**
dont : Russie	16,1	12,6	12,4	- 1,2	- 22,8
UE à 28	9,1	7,1	6,7	- 5,7	- 26,1
dont : UE à 15	9,0	7,2	6,7	- 6,4	- 25,1
Allemagne	12,5	9,8	9,3	- 5,5	- 25,9
Espagne	5,8	5,2	5,1	- 1,3	- 12,0
France	6,7	5,5	5,0	- 9,1	- 25,4
Italie	7,5	6,0	5,5	- 7,7	- 26,0
Royaume-Uni	10,1	7,2	6,5	- 9,5	- 35,4
13 nouveaux États membres	9,4	6,7	6,5	- 2,1	- 30,8
Afrique	**1,1**	**1,0**	**1,0**	**- 0,3**	**- 3,2**
Moyen-Orient	**7,6**	**12,6**	**12,8**	**+ 1,6**	**+ 67,3**
dont Arabie Saoudite	10,4	16,1	16,9	+ 5,0	+62,3
Asie	**1,8**	**4,3**	**4,3**	**+ 0,8**	**+1 33,1**
dont : Chine	2,1	7,5	7,6	+ 1,3	+ 261,9
Corée du Sud	6,2	12,4	12,3	- 0,3	+ 97,4
Inde	0,8	1,7	1,8	+ 5,9	+ 125,0
Japon	9,6	10,3	10,1	- 2,5	+5,2
Océanie	**13,6**	**15,5**	**15,0**	**- 3,1**	**+ 9,9**
Pays de l'annexe I	**12,9**	**10,9**	**10,6**	**- 2,4**	**- 17,5**
Pays hors de l'annexe I	**1,7**	**3,5**	**3,5**	**+ 0,9**	**+ 106,2**
Monde	**4,3**	**4,9**	**4,9**	**- 0,7**	**+ 15,3**

Note: these are the CO2 emissions of a territory divided by its population. The emissions that an inhabitant causes on average through his consumption fall under a different approach (the so-called footprint approach).

In 2014, CO2 emissions amounted to 4.9 t CO2 / inhabitant in the world, down compared to 2013 (-0.7%), which means that the increase CO2 emissions in 2014 (+0.5%) was lower than growth demographic (+1.2%). Per capita emissions are highest in North America (more than 16 t CO2/capita in the United States), the Middle East and in Oceania. China's per capita emissions now stand at 7.6 t CO2/capita, exceeding the level of France (5.0 t CO2/capita) and EU 28 (6.7 t CO2/capita).

EVOLUTION OF CO2 EMISSIONS PER CAPITA IN THE WORLD BETWEEN 1970 AND 2014



Sources : *SOeS d'après EDGAR, World Bank, 2015*

Since 1990, per capita emissions have increased by an average of 15% in the world. If per capita emissions in non-Annex I countries remain three times lower than in Annex I countries, we observe nevertheless a certain catch-up between these two groups of countries. Thus, by compared to 1990, per capita emissions in China have been multiplied by more than 3.5 and they have more than doubled in India. At the same time, the CO2 emissions per capita have fallen sharply in the EU (-26%) and to a lesser extent in the United States (-16%).

CO2 EMISSIONS IN RELATION TO GDP WORLDWIDE (EXCLUDING LULUCF)

En t CO_2 / Million $ 2011 PPA	1990	2013	2014	Évolution (%) 2014/2013	Évolution (%) 2014/1990
Amérique du Nord	**512**	**320**	**315**	**- 1,7**	**- 38,4**
dont : Canada	519	384	375	- 2,3	- 27,7
États-Unis	540	326	321	- 1,5	- 40,6
Amérique Centrale et du Sud	**194**	**179**	**179**	**+ 0,1**	**- 7,7**
dont : Brésil	145	166	172	+ 3,6	+ 18,6
Europe et ex-URSS	**565**	**316**	**307**	**- 2,6**	**- 45,6**
dont : Russie	829	530	519	- 2,1	- 37,4
UE à 28	365	208	194	- 6,7	- 46,8
dont : UE à 15	312	192	178	- 7,3	- 42,9
Allemagne	403	209	191	- 8,4	- 52,6
Espagne	242	165	161	- 2,4	- 33,5
France	222	144	131	- 9,0	- 41,0
Italie	243	179	166	- 7,3	- 31,7
Royaume-Uni	383	193	171	- 11,4	- 55,4
13 nouveaux États membres	780	306	291	- 4,9	- 62,7
Afrique	**551**	**234**	**226**	**- 3,4**	**- 59,0**
Moyen-Orient	**388**	**421**	**424**	**+ 0,7**	**+ 9,1**
dont Arabie Saoudite	294	308	318	+ 3,2	+ 8,2
Asie	**490**	**426**	**411**	**- 3,5**	**- 16,1**
dont : Chine	1 327	656	617	- 5,9	- 53,5
Corée du Sud	517	371	359	- 3,2	- 30,6
Inde	423	331	333	+ 0,6	- 21,3
Japon	321	290	282	- 2,8	- 12,1
Océanie	**528**	**401**	**385**	**- 4,1**	**- 27,2**
Pays de l'annexe I	**485**	**297**	**287**	**- 3,5**	**- 40,8**
Pays hors de l'annexe I	**442**	**382**	**372**	**- 2,5**	**- 15,7**
Monde	**484**	**353**	**344**	**- 2,7**	**- 28,9**

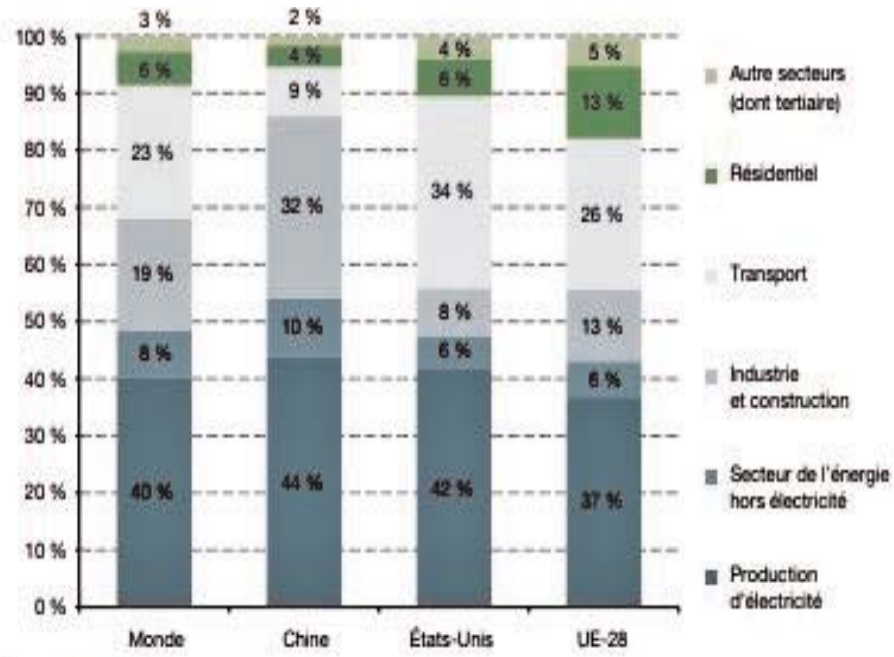
Note: GDP in volume, converted into United States dollars in purchasing power parity (PPP) for the year 2011.

Sources : *SOeS d'après EDGAR, World Bank, 2015*

The quantity of CO2 emitted per unit of GDP continues to decrease at the level worldwide with a drop of 2.7% in 2014. The disparities between countries are important with high values in China (more than 600 t CO2/Million $) or in Russia. The United States (321 t CO2/Million $) or Japan are slightly below the world average, while the lowest values are observed in the EU (194 t CO2/Million $), particularly in France

Sectoral distribution of CO2 emissions in the world due to the energy burning

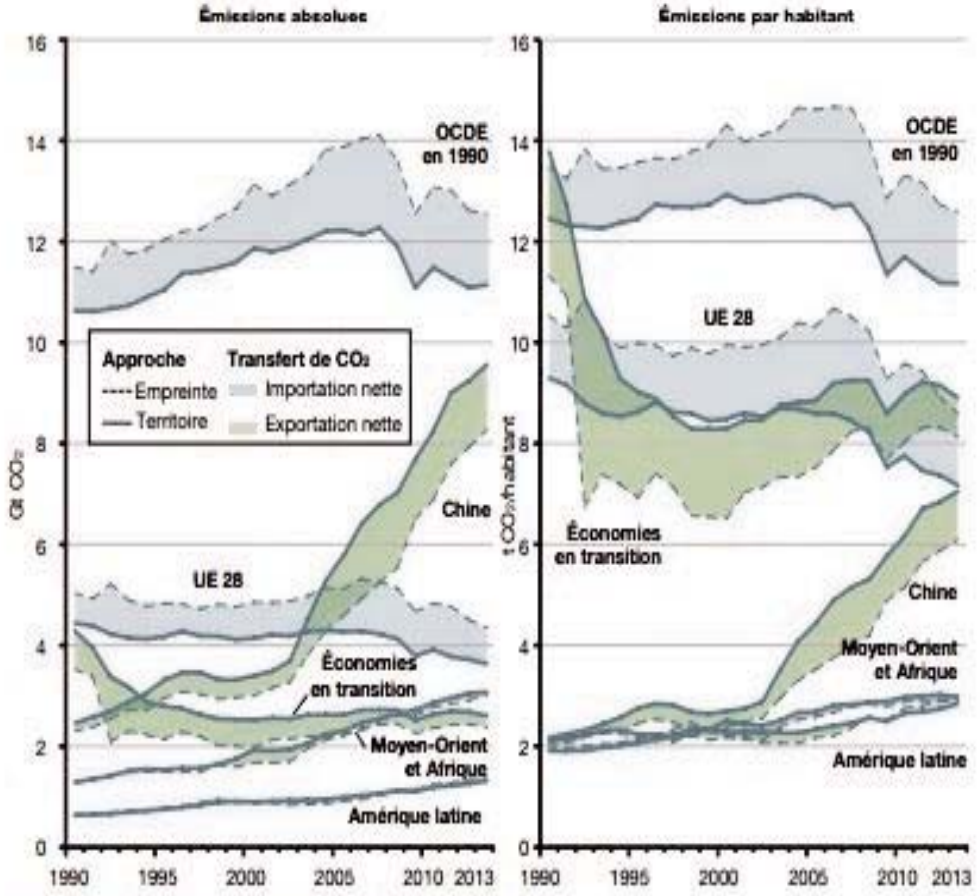
ORIGIN OF CO2 EMISSIONS DUE TO COMBUSTION OF ENERGY AMONG THE MAIN TRANSMITTERS IN 2013



Source : *AIE, 2015*

In 2013, with 40% of global CO2 emissions due to combustion of energy the production of electricity is the leading emitting sector. Are coming then transport (23%) and industry (19%). In China, production electricity (44%) and industry (32%) have an above-average share world. As for the transport sector, it contributes more than the average emissions in the European Union (26%) and especially in the United States (34%).

INTERNATIONAL COMPARISON OF CO2 EMISSIONS DUE TO ENERGY COMBUSTION ACCORDING TO THE APPROACHES



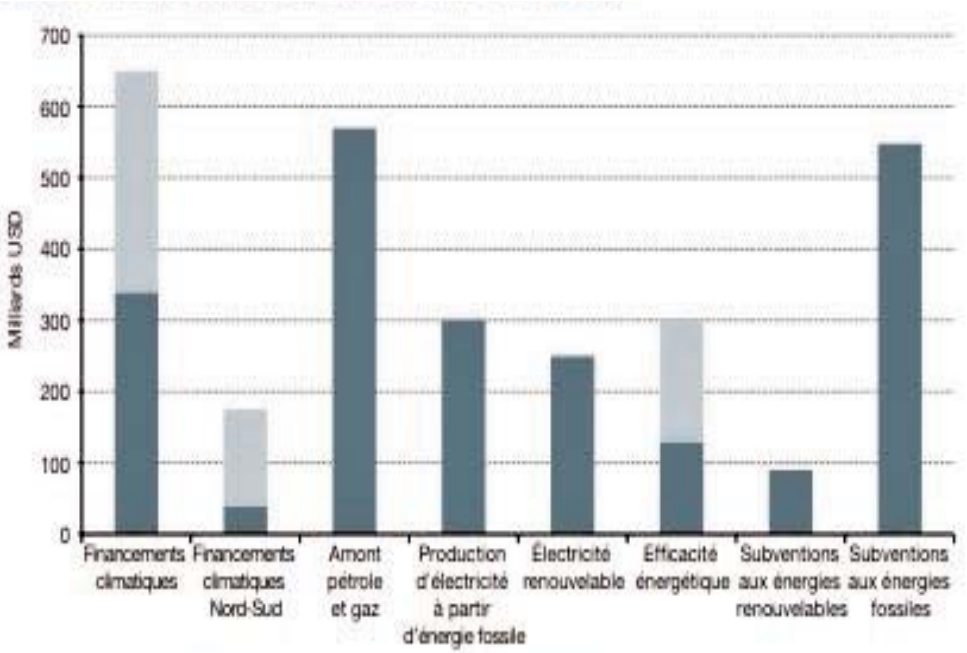
Source : *I4CE à partir de Global Carbon Budget, 2015*

Between 1990 and 2013, CO2 emissions related to the combustion of energy in the OECD increased by 5% according to the territory approach, and by 9% according to the footprint approach. Over this period, they decreased by 18% in the EU 28 according to the territory approach and only by 14% according to the footprint approach. They have almost tripled in China, whatever the approach.

Emissions per capita in China are now equivalent to those in the EU 28, according to the territory approach. On the other hand, according to the footprint approach, emissions per capita are 30% lower in China than in the EU 28 (and more than 50% lower than the OECD average).

Financing the fight against climate change

ESTIMATE OF ANNUAL INVESTMENTS AND SUBSIDIES WORLDWIDE (2010-2012)



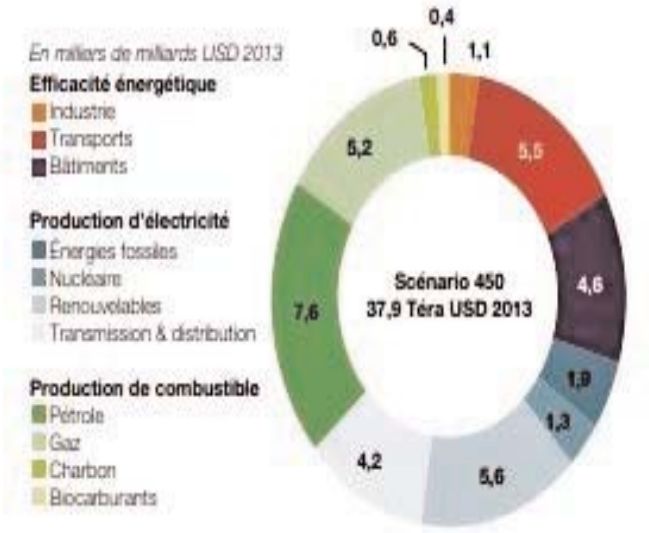
The light blue bar represents the high range of the estimate The dark blue bar represents the low range of the estimate

Source : *Comité permanent du financement, 2014*

Climate finance North-South climate finance Upstream oil and gas Electricity generation from fossil fuels Renewable electricity Energy efficiency Renewable energy subsidiesFossil fuel subsidies

Climate finance (climate finance) brings together all the financial flows allowing the implementation of actions having a positive impact in terms of mitigation (reduction of GHG emissions) or adaptation to climate change. Depending on the organizations and definitions, distinctions may exist depending on the level of impact and whether it is a co -benefit or a main objective of the funded action.

GLOBAL ENERGY INVESTMENTS NEEDED BETWEEN 2015 AND 2030 ACCORDING TO THE IEA 450 SCENARIO

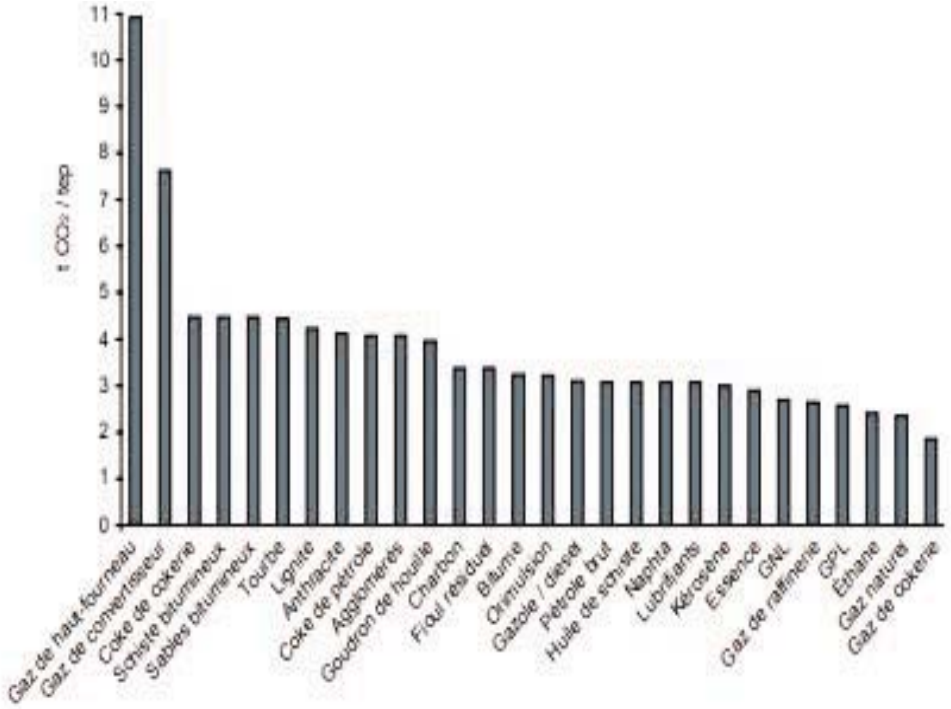


Source : *Agence internationale de l'énergie, juin 2015*

Achieving the 2°C objective requires mobilizing significant amounts - of the order of one or several trillion dollars per year by 2030 - for all sectors. This mobilization concerns both the production and the use of energy. A scenario based on the continuity of current needs requires significant investments, whatever the level of climatic constraint.

The difference between a trend scenario and a 450 ppm scenario - i.e. which has a 50% chance of limiting the temperature increase to 2°C thanks to a limitation of the concentration of CO2 in the atmosphere at 450 ppm - mainly concerns the allocation of investments . Indeed, greater investments are needed in low carbon technologies and energy efficiency in a 450 ppm scenario but lesser investments are required in the production of fossil fuels for example.

CO2 EMISSION FACTORS OF THE MAIN FOSSIL FUELS



Source : *Giec, lignes directrices pour les inventaires nationaux de gaz à effet de serre, 2006*

CO2 emission factors indicate the average amount of CO2 emittedduring the combustion of a given fuel for the production of a unit of energy (here ton-oil equivalent or toe). They are calculated by relating them CO2 emissions measured at the amount of energy produced.

These emission factors are standard values and can be refined by country. The particular case of biomass is not dealt with here: it is considered that the CO2 emissions related to the combustion of biomass are offset by the assimilation of CO2 which will take place during the reconstitution of this biomass. If this is not the case, the uncompensated emissions are recorded in the LULUCF sector.

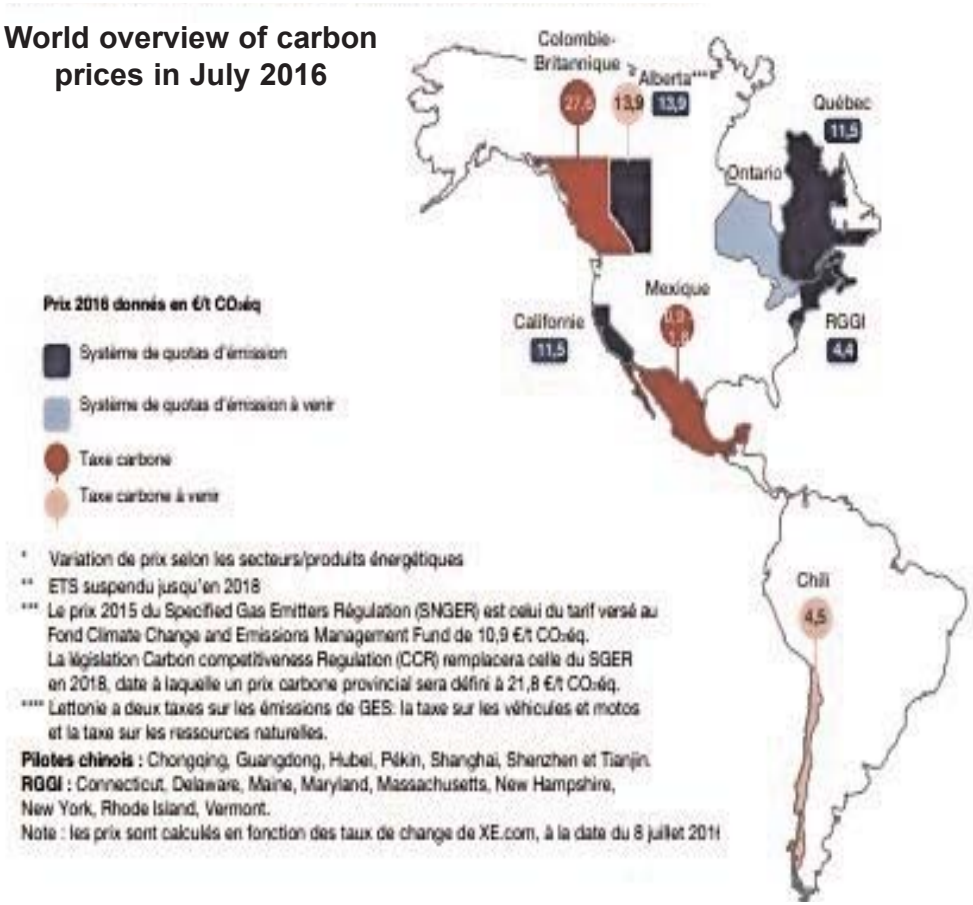
Carbon pricing around the world

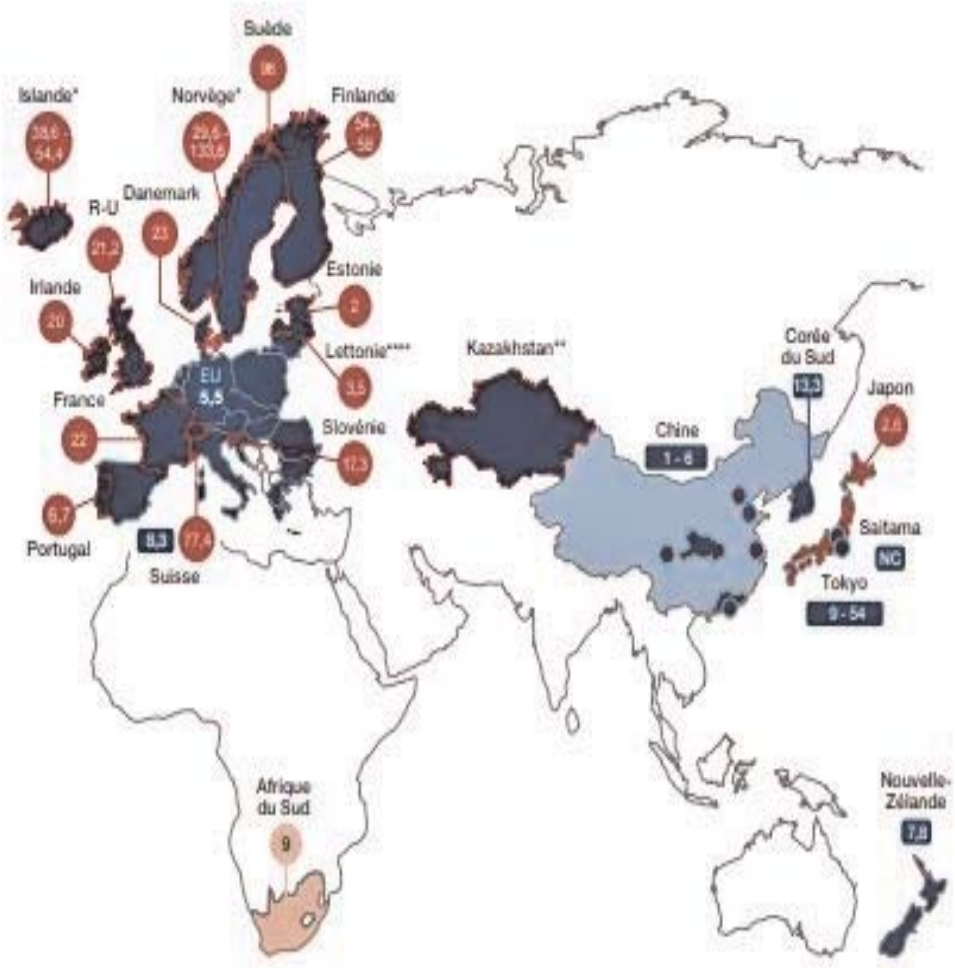
To encourage economic decision-makers to invest more in clean energies or low-carbon technologies and less in technologies that promote GHG emissions, some States have decided to give an economic value to the emission of one teq.CO2. Several economic instruments are included in the toolbox of public climate policies to create a carbon price.

More than 40 countries, and 20 provinces or cities , have or are planning to introduce carbon pricing. Among them are large emitters such as China, South Korea, Europe, South Africa, Japan and Mexico.

In 2016, 13% of global emissions were thus covered by an explicit price mechanism. These carbon pricing policies currently include 15 cap-and-trade schemes and 16 carbon taxes.

World overview of carbon prices in July 2016


Colombie-Britannique
27,5
Alberta***
13,9
13,9
Québec
11,5
Ontario
Mexique
Californie
11,5
RGGI
4,4
Chili
4,5
Prix 2016 donnés en €/t CO2éq
Système de quotas d'émission
Système de quotas d'émission à venir
Taxe carbone
Taxe carbone à venir
* Variation de prix selon les secteurs/produits énergétiques
** ETS suspendu jusqu'en 2018
*** Le prix 2015 du Specified Gas Emitters Régulation (SNGER) est celui du tarif versé au Fond Climate Change and Emissions Management Fund de 10,9 €/t CO2éq. La législation Carbon competitiveness Regulation (CCR) remplacera celle du SGER en 2018, date à laquelle un prix carbone provincial sera défini à 21,8 €/t CO2éq.
**** Lettonie a deux taxes sur les émissions de GES: la taxe sur les véhicules et motos et la taxe sur les ressources naturelles.
Pilotes chinois : Chongqing, Guangdong, Hubei, Pékin, Shanghai, Shenzhen et Tianjin.
RGGI : Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, Vermont.
Note : les prix sont calculés en fonction des taux de change de XE.com, à la date du 8 juillet 2016



Source : I4CE

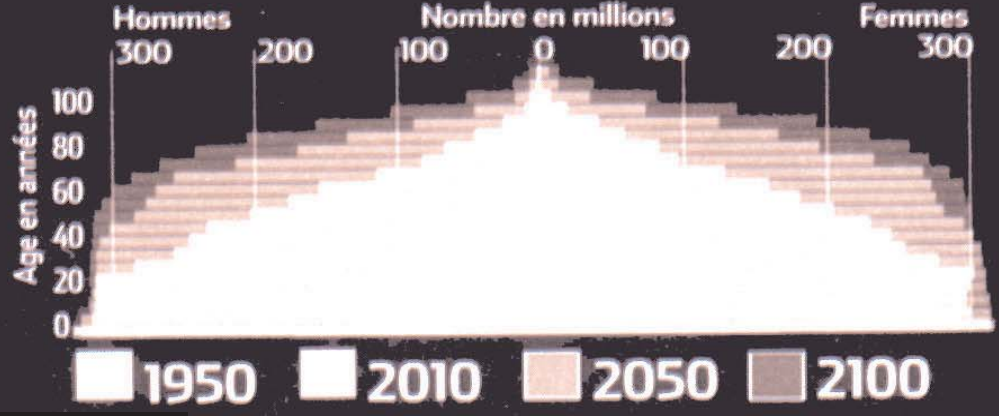
DEMOGRAPHY

The explosion will take place in Africa

While the population density decreases in Dog like Europe, that of India should continue to increase. However, it is in Africa that the increase will be the most spectacular: forecasts place Nigeria among the most densely populated countries in 2100, with 790.2 inhabitants per square kilometre.

All ages will live together

In 2100, the global age pyramid should everywhere take the form it has today in rich countries, ie as many individuals aged 20, 40 or 60 years old. The median age of the world's population will be 41.9 years.



We will live longer and longer.

Life expectancy is expected to rise sharply, especially in developing countries, where it will come very close to that of rich countries. The lowest predicted life expectancy thus goes from 48.5 years in 2013 to 74.5 years in 2100 in Sierra Leone.

Fewer and fewer children per woman

The decline in children per woman is expected to slow this century

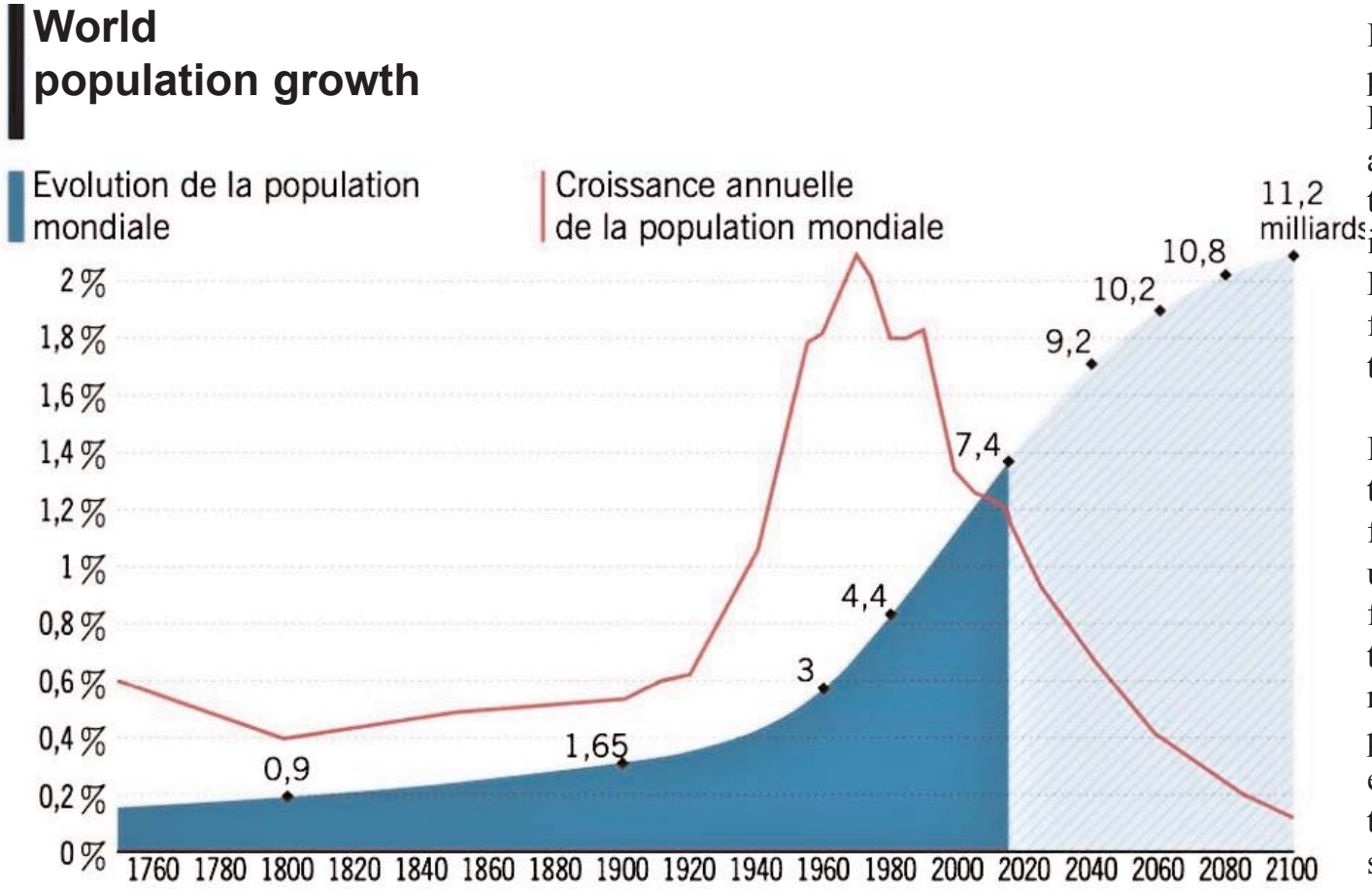
92,5 ANS

This is the expected life expectancy in Japan in 2100

Today (2017), we are more than 7.6 billion human beings on Earth (latest revision of the United Nations, in its June 2017 report). According to the latest projections, there will be 9.5 billion of us by 2050. These forecasts can be explained by the population explosion in emerging countries and the lengthening of life expectancy in developed countries.

According to the sources, demographic projections for the end of the century vary between 7 and 11 billion inhabitants. How can such disparities be explained? Why do the experts fail to give us reliable figures?

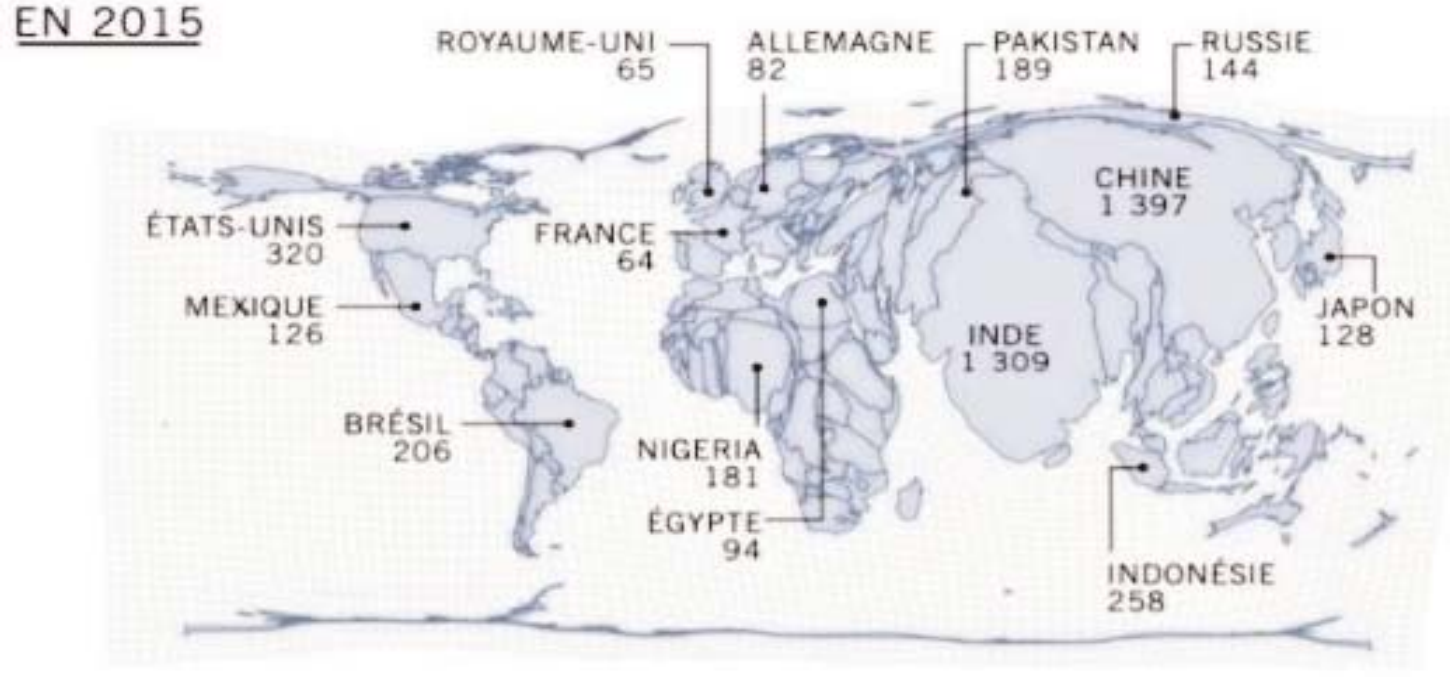
In the 1960s, it was thought that the world's population would grow indefinitely. In his book "The P Bomb" (The Population Bomb in English), published in 1968, the American demographer Paul R. Ehrlich then warned of a "massive famine" during the 1980s due to overpopulation. But, after a peak of 2.05% per year in the years 1965-1970, world population growth began to slow down to 1.1% today. This may not seem like much, but according to the latest UN projections, this still brings us to 9.7 billion inhabitants in 2050 and 11 billion by the end of the century. However, there are considerable discrepancies between the forecasts. A study by the Institute for Health Metrics and Evaluation (IHME) at the University of Washington thus estimated, in 2020, that the plateau would not exceed 8.8 billion in 2100, i.e. a margin of error of more than two billion (see below)! Another organization, the International Institute for Applied Systems Analysis (IIASA) in Vienna, is betting on a peak of just over 9.7 billion around 2070.

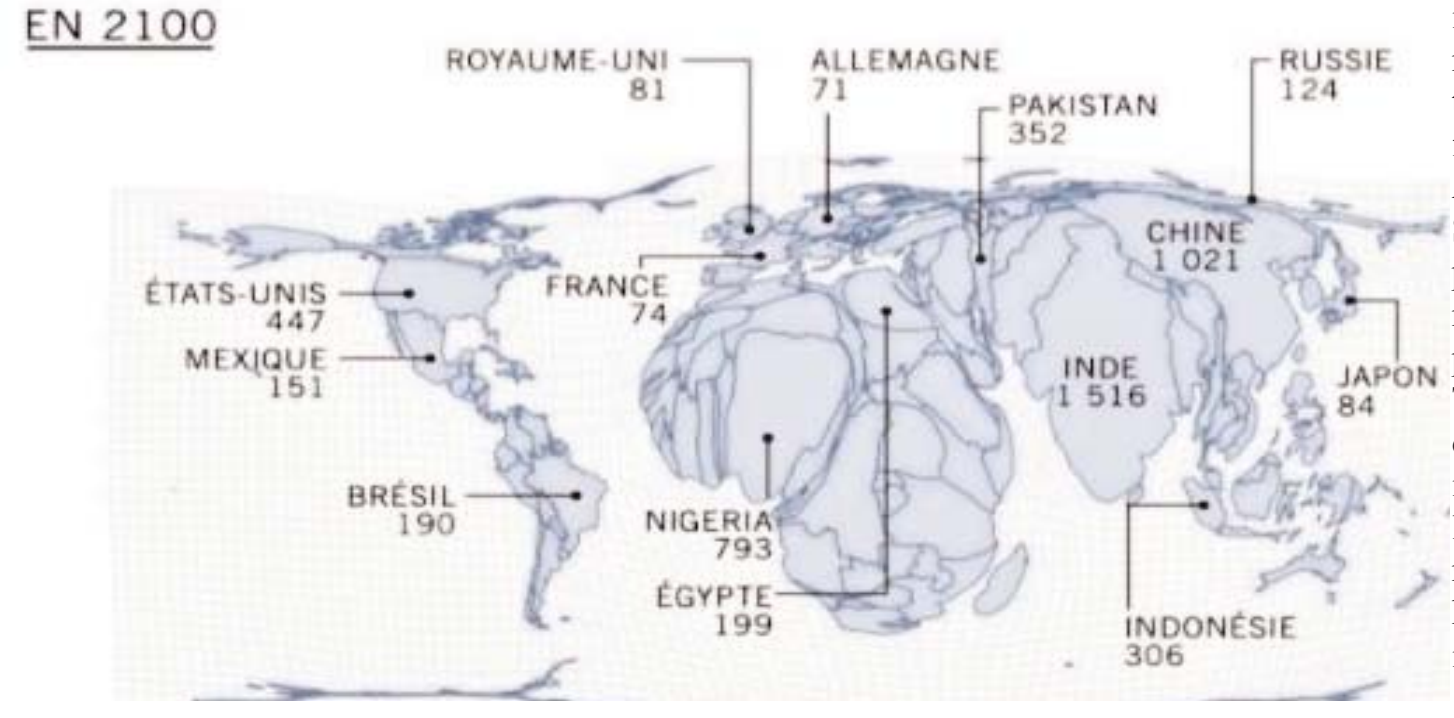


In the short term, it is relatively easy to predict the evolution of the population. Projections 20 or 30 years out are generally considered good because most of the people who will be alive in the coming decades have already been born. Birth, death and migration rates are also fairly easy to extrapolate from recent trends.

In the longer term, things get much tougher. It is necessary to extrapolate fertility rates, which depend on individual and social behavior and are very difficult to anticipate. "Beyond ten years, the forecasts are very uncertain and have not proven to be very accurate in the past when we always use the same models", notes Hervé Le Bras, professor at the School advanced studies in the social sciences.

The other factor of uncertainty is due to what we would call in physics a strong sensitivity to the initial conditions, or in meteorology to the "butterfly effect". "The volume of the population after several decades is very sensitive to small variations in the fertility index. This makes certain forecasts more risky over the very long term", explains Bruno Tertrais in a note from the Institut Montaigne.





Significant inertia effects

"In terms of demography, changes are slow, the effects of inertia are significant. It often takes several generations to reverse a situation", continues the researcher. In China, for example, despite the gradual relaxation of the one-child policy since 2015, the birth rate remains at its lowest, with barely 10.48 births per 1,000 inhabitants in 2020, its lowest rate since 1949.

Some unexpected events can nevertheless play out in the short term. The Covid-19 pandemic, for example, reduced the number of births by 8.9% in January 2021 compared to the same month of the year in a set of 17 countries, according to a pre-publication from the University of Vienna. in Austria, with a drop of up to 20% in Spain. And no one knows if it is simply a time lag or if this delay will never be caught up. Other longer-term phenomena can also derail forecasts. Thus, while progress in the standard of living has hitherto been a factor in increasing lifespan, changes in lifestyles such as obesity could reverse the trend. Since 2012, there has been a decline in life expectancy in the United States, due in particular

to deaths by overdose (drugs and opioids).

Divergent scenarios
The UN forecasts have nevertheless proven to be relatively reliable historically. In 1968, for example, the United Nations predicted a world population of 5.44 billion in 1990, relatively close to the actual figure (5.34 billion). The institution also prefers to publish ranges with different scenarios. For its low hypothesis, the world population would increase to reach 8.9 billion people in 2050 before falling back to 7.3 billion in 2100. An even more pessimistic scenario than that of the IHME.

According to a new study, the Earth will have about 8.8 billion inhabitants by 2100. This is two billion people less than the UN predictions.

Last year, the United Nations predicted a world population of almost 11 billion by 2100. However, a new study published in the journal The Lancet offers a different perspective. Using new projection methods, the researchers attempted to model mortality, fertility, and population movements for the next 80 years, arriving at the final result of 8.8 billion people by 2100, or two billion below UN predictions.

Population redistribution
"Understanding potential patterns of future population levels is crucial for anticipating and planning for shifts in age categories, resources and health needs, as well as for considering environmental and economic landscapes," the team explains in the introduction. of the study. The population is predicted to peak in 2064 at 9.3 billion, before gradually declining as the end of the century approaches.

More than twenty countries, including Japan, Spain, Italy, Portugal, South Korea, and even Poland, will see their workforce reduced by half. China would drop from 1.4 billion souls to just 730 million. Sub-Saharan Africa, meanwhile, would triple in population, with Nigeria becoming the second most populous country in the world behind India, with 800 million people. According to the researchers, the fall in the fertility rate will bring 183 out of 195 countries below the population replacement level without the implementation of a more liberal immigration policy.

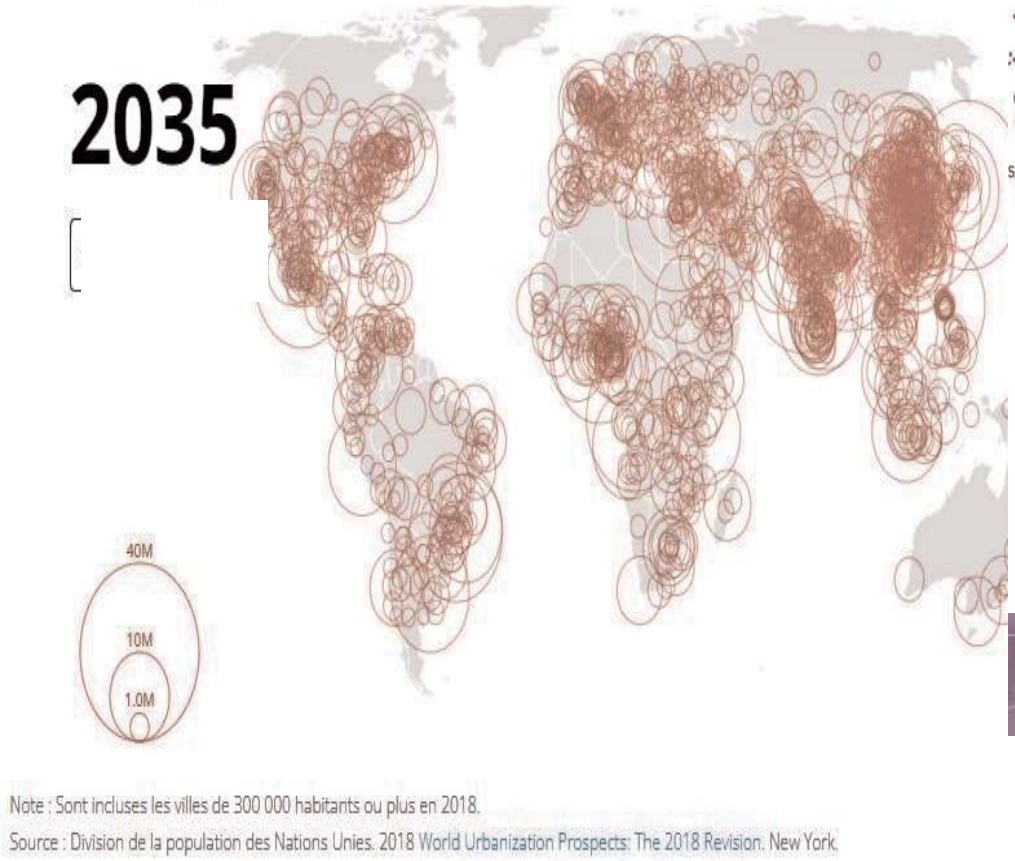
According to the UN, nearly 70% of the world's population will live in cities by 2050. Against "only" 55% today. A galloping urbanization movement. And an estimate reinforced today by the work of researchers who predict the surface area occupied by cities in the world could be multiplied by almost six by 2100!

Between 1985 and 2015, each year, nearly 10,000 km2 of land - it is a little less than the area of Île-de-France - were invested by the city in the world. This is the conclusion of a study based on very precise satellite images. Over this period, the area occupied by cities has increased from some 360,000 km2 to more than 650,000 km2. That's an increase of about 80%. An unprecedented global rate of urbanization. Four times higher than previous estimates. And in extreme scenarios, the area of the world's cities could even increase sixfold!

CITIES AND PEOPLE

Of the 4.2 billion people in the world's urban population, 60% - or 2.6 billion people - live in cities with more than 300,000 inhabitants, and this figure is expected to reach 3.3 billion by to 2035. From 355 in 1955, the number of these large metropolises has increased to 1,861 today.

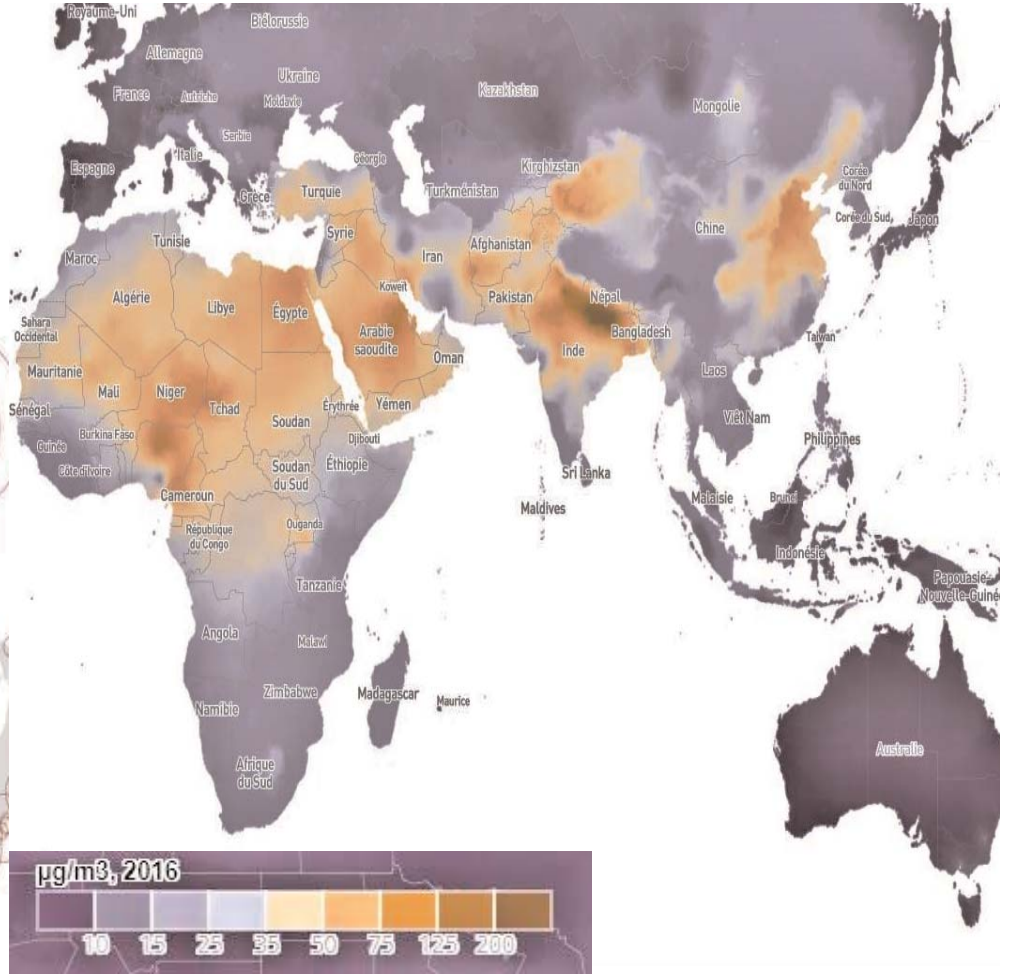
Growth of urban agglomerations
1995 - 2035



Note : Sont incluses les villes de 300 000 habitants ou plus en 2018.
Source : Division de la population des Nations Unies. 2018 World Urbanization Prospects: The 2018 Revision. New York.

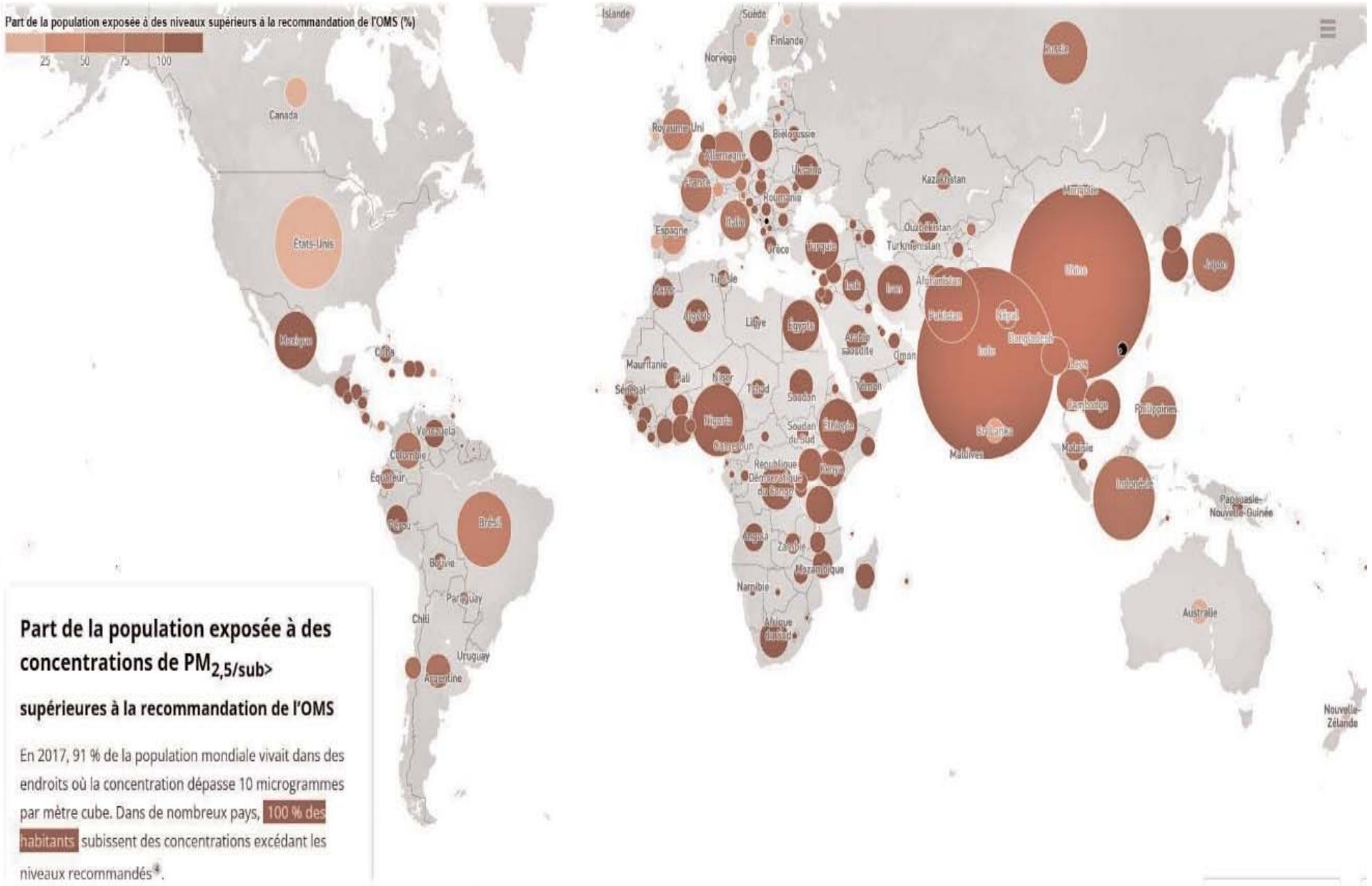
Given the important role of cities in global development, it is important to ensure that cities and human settlements are inclusive, safe, resilient and sustainable by reducing the negative environmental impact of cities, including air pollution .

The following indicator assesses how air quality (specifically the annual average level of fine particles) affects people living in urban areas.

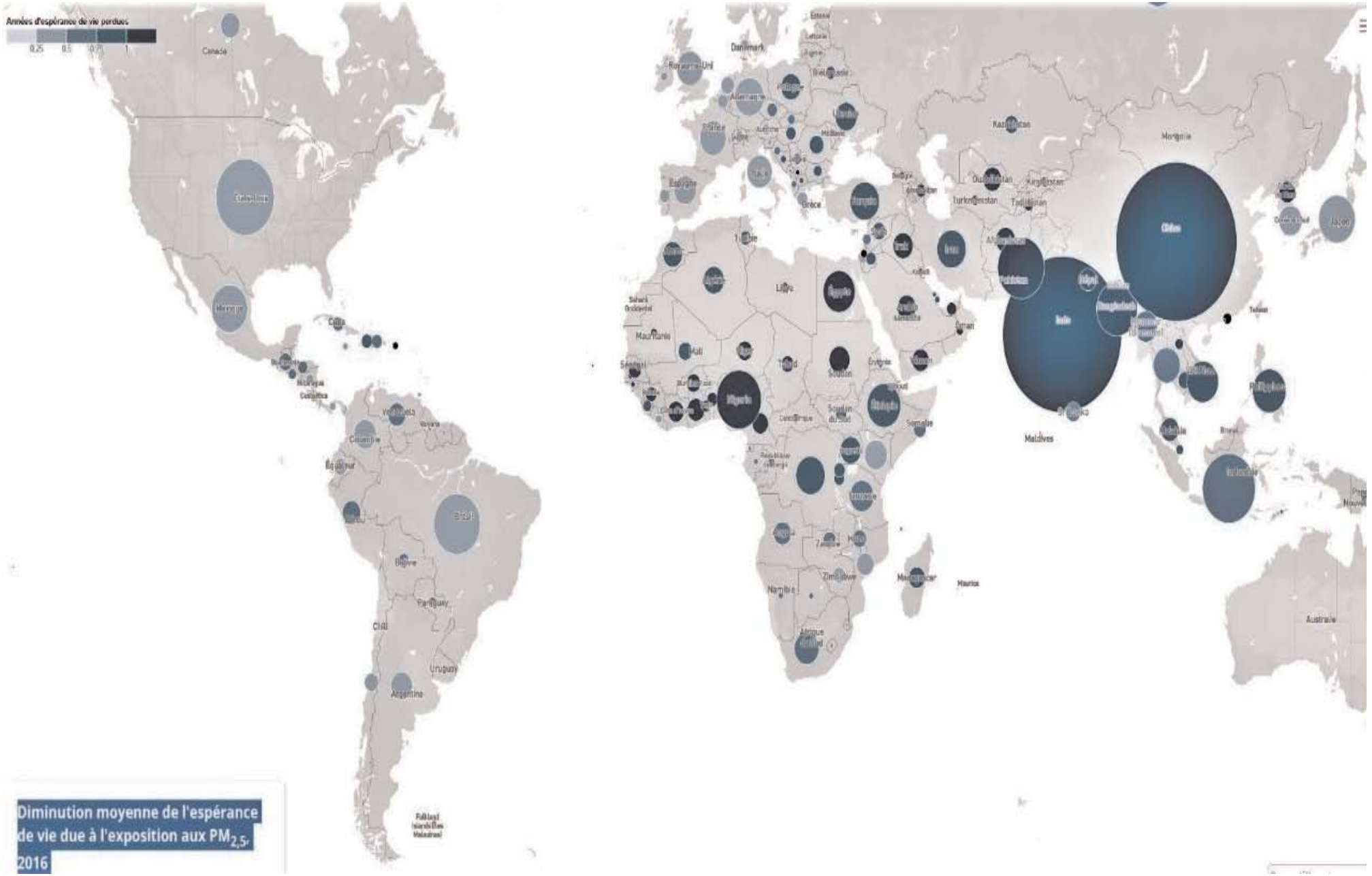


PM2.5 concentration, 2016

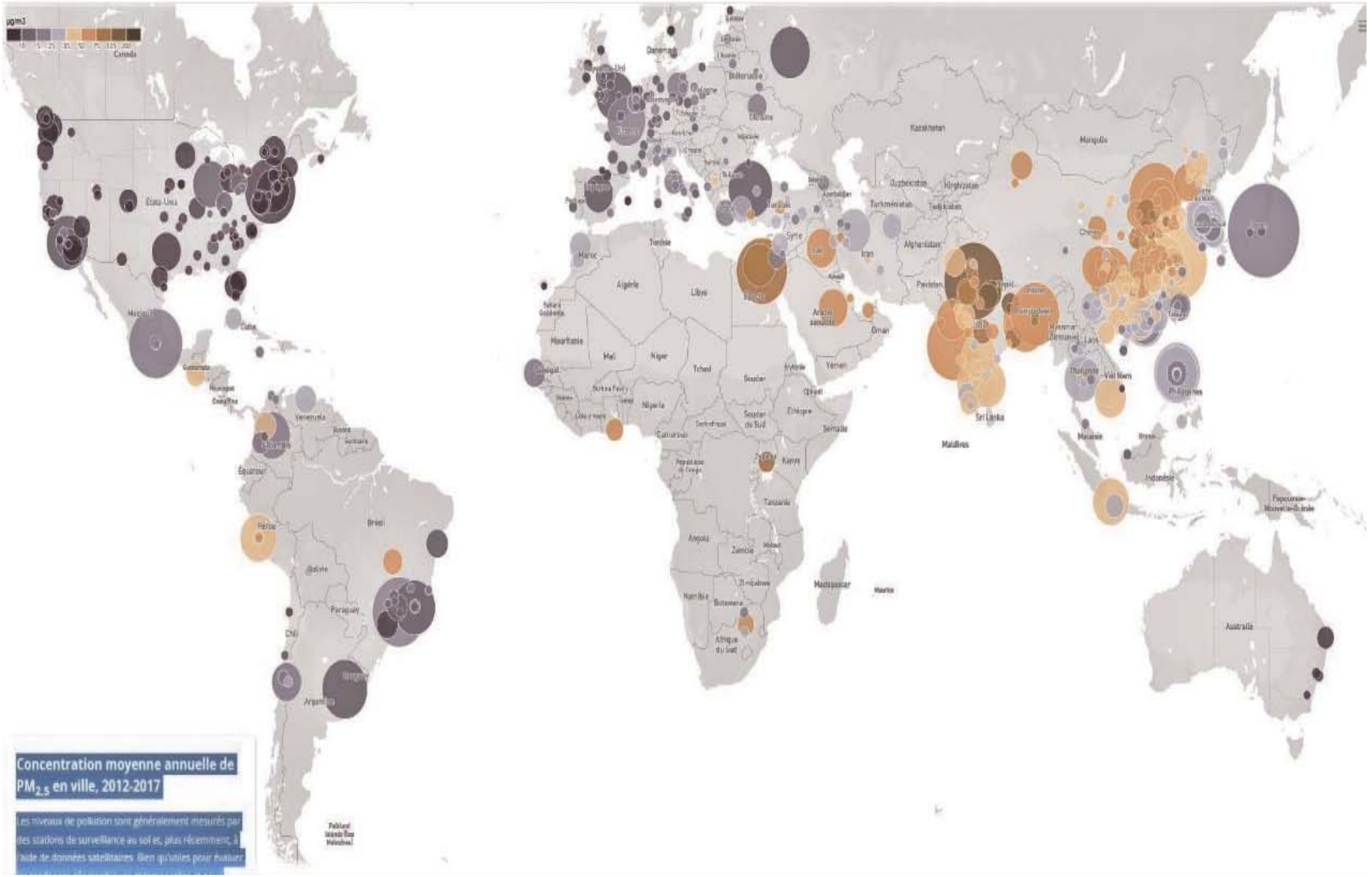
To limit the long-term harmful effects of PM2.5 exposure, World Health Organization (WHO) guidelines recommend an annual average of 10 micrograms per cubic meter. The WHO has set three intermediate targets (IT) to promote the reduction of concentrations: 35 (IT-1)), 25 (IT-2) and 15 (IT-3). Concentrations well above these levels are still observed in many places around the world.


Part de la population exposée à des niveaux supérieurs à la recommandation de l'OMS (%)
25
50
75
100
Part de la population exposée à des concentrations de PM2,5/sub>
supérieures à la recommandation de l'OMS
En 2017, 91 % de la population mondiale vivait dans des endroits où la concentration dépasse 10 microgrammes par mètre cube. Dans de nombreux pays, 100 % des habitants subissent des concentrations excédant les niveaux recommandés[4].

Part of the population exposed to PM 2.5 particles above WHO recommendations



Decreased life expectancy due to PM 2.5 concentration (2016)


Concentration moyenne annuelle de PM2,5 en ville, 2012-2017
Les niveaux de pollution sont généralement mesurés par des stations de surveillance au sol et, plus récemment, à l'aide de données satellitaires. Bien qu'utiles pour évaluer

Average annual city concentration of PM 2.5 (2012 - 17)

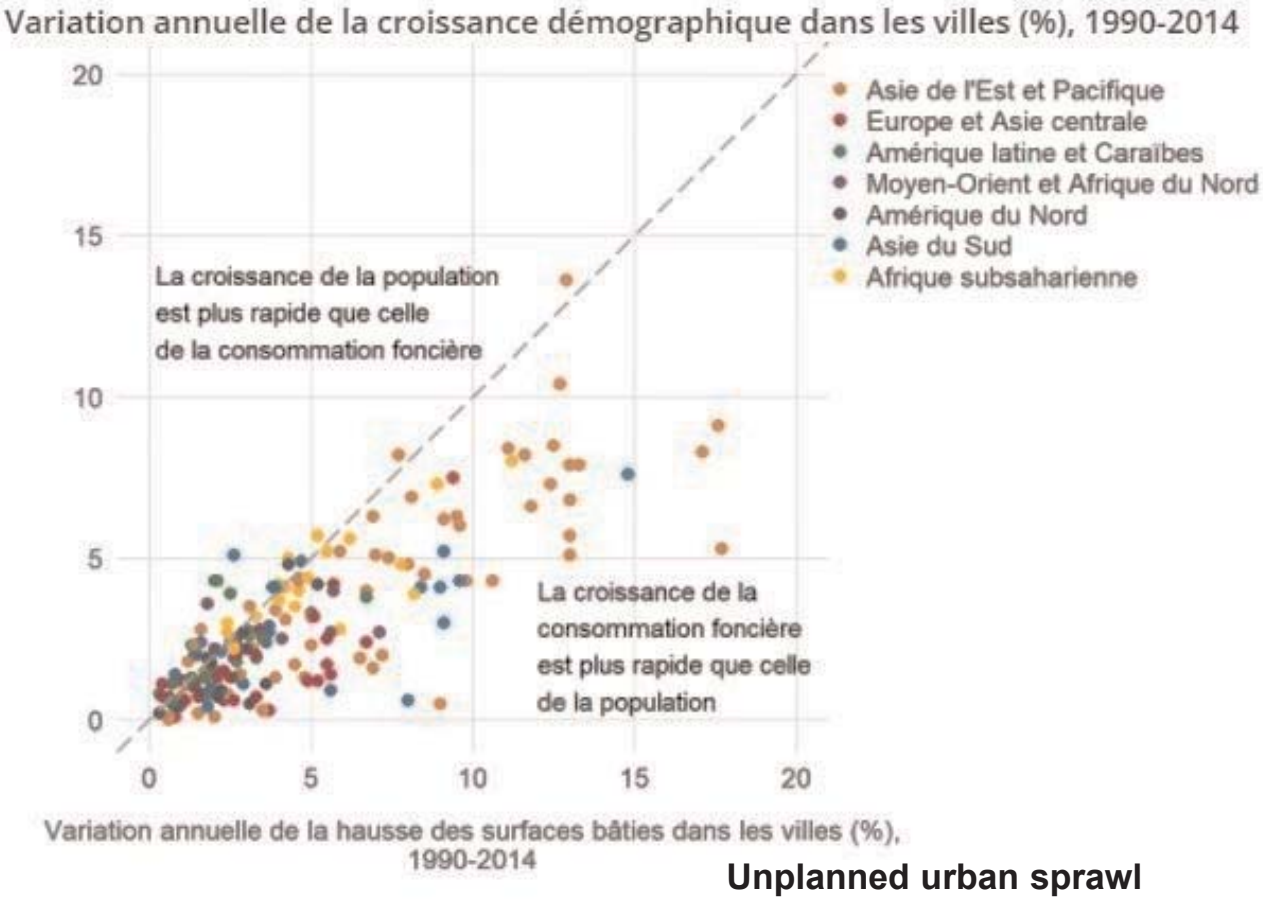
Pollution levels are usually measured by ground-based monitoring stations and, more recently, using satellite data. While useful for assessing geographic and temporal trends and for spotting hotspots, these also have limitations due to clouds and precipitation that often interfere with detection by satellites. Scientists therefore refer to ground measurement stations to obtain more precise information. However, these stations are generally only found in cities and require expensive equipment, technical expertise and regulatory incentives.

More recently, the air has become cleaner again in some cities due to massive restrictions on economic activity due to COVID-19. Thus, the concentration of nitrogen dioxide produced by automobile traffic has fallen sharply. On the other hand, the decrease in harmful pollutants such as fine particles has not been as marked. Factors such as fossil fuel use and dust still outweigh the reduction induced by the drop in economic activity resulting from the pandemic. The fact that local measures alone cannot substantially limit fine particle levels reinforces the World Bank's conclusion that the air knows no borders: no city can solve this problem alone. As particles move from region to region and between cities and rural areas, collective and coordinated action is essential.

Cities will need to implement proactive strategies and work with rural areas to reduce air pollution beyond their own borders. The example of China shows that change is possible. By applying data-driven solutions, cities can better tackle air pollution and promote resilience and sustainable development.

The size of cities is growing faster than their population.

Dans la plupart des pays, l'augmentation du grignotage des terres par les villes est plus rapide que celle de leur population. Au vu de la croissance de la population urbaine dans le monde, cette tendance du rapport entre la hausse des surfaces bâties et celle de la population indique une croissance non planifiée des villes (cible 11.3 des ODD).


Variation annuelle de la croissance démographique dans les villes (%), 1990-2014
20
15
10
5
0
0
5
10
15
20
Asie de l'Est et Pacifique
Europe et Asie centrale
Amérique latine et Caraïbes
Moyen-Orient et Afrique du Nord
Amérique du Nord
Asie du Sud
Afrique subsaharienne
La croissance de la population est plus rapide que celle de la consommation foncière
La croissance de la consommation foncière est plus rapide que celle de la population
Variation annuelle de la hausse des surfaces bâties dans les villes (%), 1990-2014

Unplanned urban sprawl

Les villes sont définies par l'étendue de la zone bâtie, plutôt que par leurs limites administratives.
Source : Atlas of Urban Expansion

In its broadest sense, the concept of poverty corresponds to the inability of an individual to achieve a certain level of well-being, in terms of food, clothing, transport, public services, health, wealth or even leisure. We are interested here in poverty in a stricter sense and limited to a monetary dimension measured by the level of income or consumption. The most severe form of poverty targeted by the SDGs is extreme poverty, defined as living on less than $1.90 a day regardless of where you live.

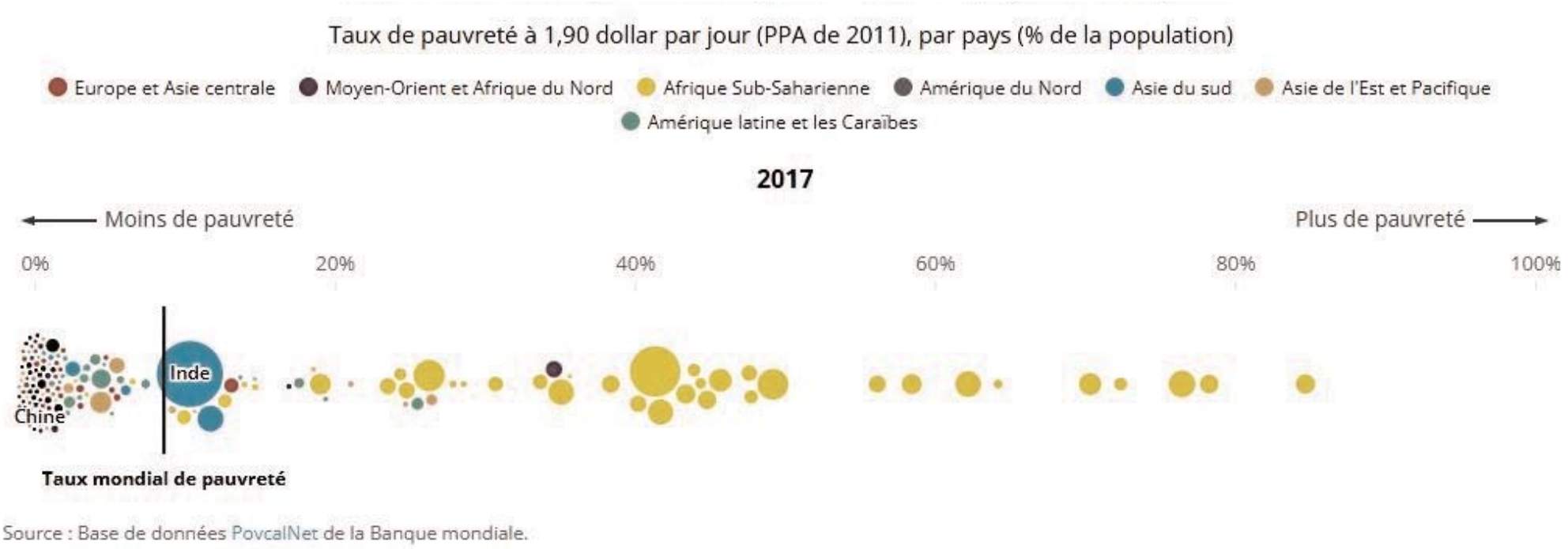
In the early 1990s, the global prevalence of extreme poverty was over 30%, but this average masked large disparities between countries. In some of them, such as those in Europe and North America, extreme poverty was virtually non-existent, while a few countries in sub-Saharan Africa, East Asia and South Asia had extreme poverty rates above 70%.

While the countries of the world were scattered along this line, two particularly populous and very poor nations - China and India - had 60% of the extremely poor.

The decline in poverty in the world since 1993 is essentially due to the economic performance of these two countries. Of the 1.2 billion people who escaped extreme poverty between 1993 and 2017, 969 million (or 80%) lived in China and India.

China saw its extreme poverty rate fall from 57% in 1993 to less than 1% in the most recent year of the national household survey. India has achieved less spectacular, but still substantial results: it halved its extreme poverty rate between 1993 and 2011, and the rate for 2017 is estimated to be just above average 9.2% worldwide. India should continue to contribute significantly to the reduction of extreme poverty in the world.

Poverty is unevenly distributed across countries and regions



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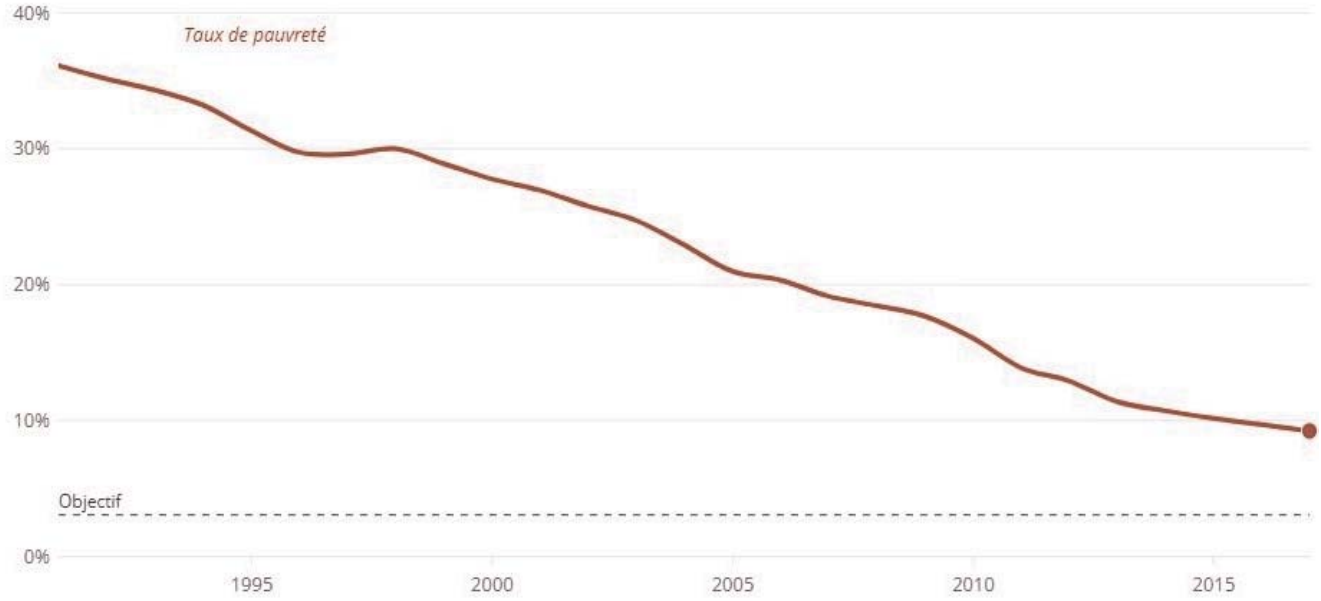
Eradicating poverty by 2030 seems unlikely



Sources : Base de données PovcalNet de la Banque mondiale ; C. Lakner, D. Mahler, M.E. Prydz. 2020. How Much Does Reducing Inequality Matter for Global Poverty?. Global Poverty Monitoring Technical Note 13, Banque mondiale.

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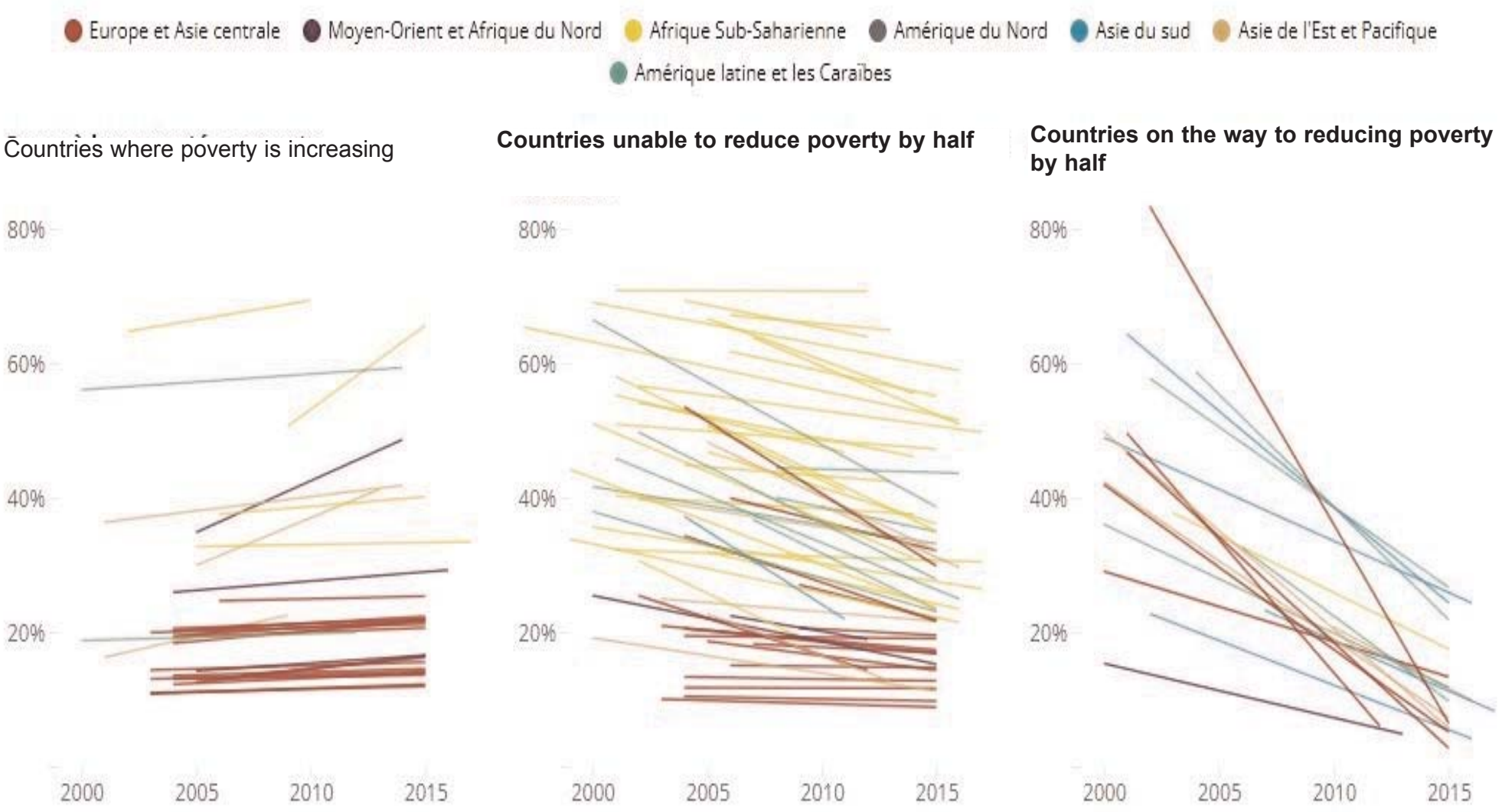
Poverty rate according to national thresholds (% of population)

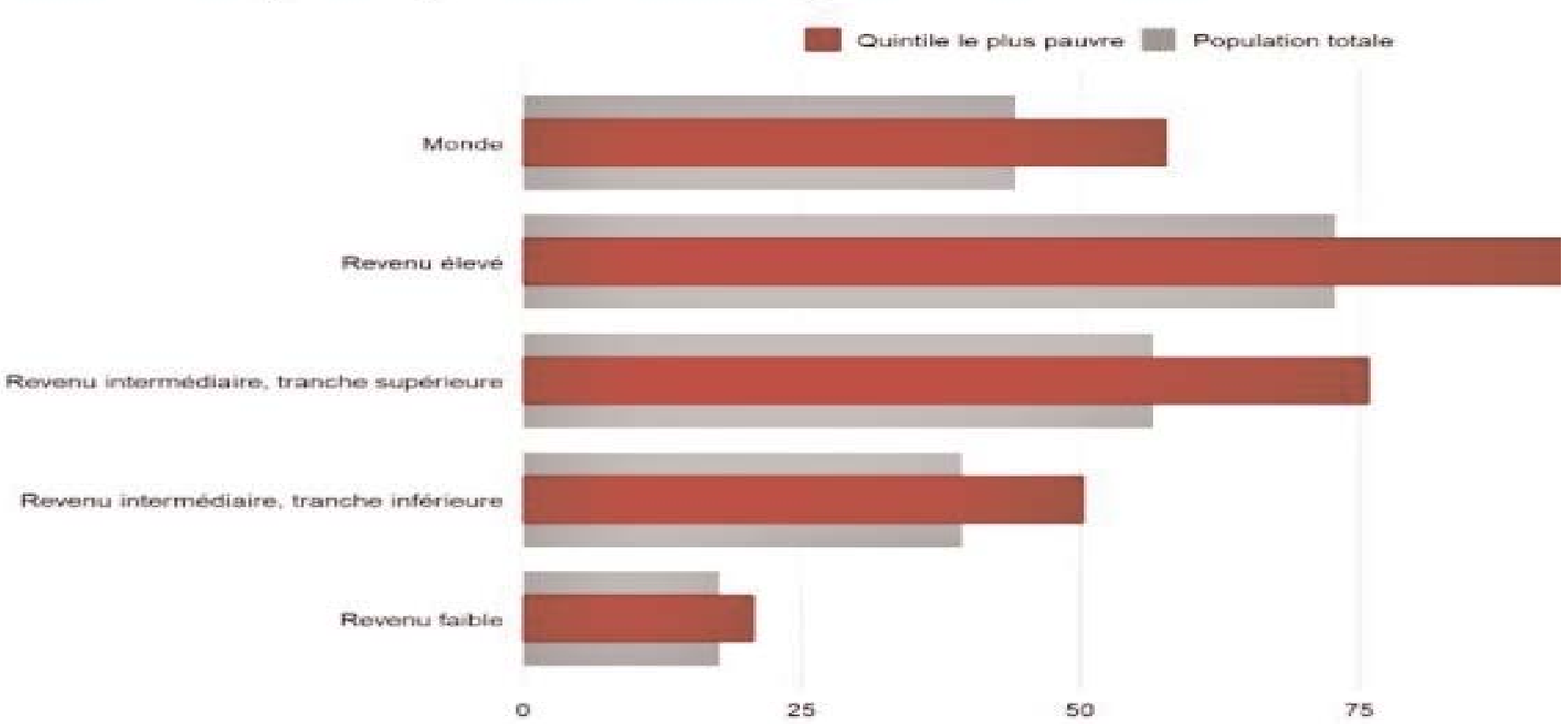


Source : Banque mondiale. Indicateurs du développement dans le monde (SI.POV.NAHC).

And in sub-Saharan Africa, the number of extremely poor people has actually increased. Eight of the ten countries with the highest number of people living in extreme poverty are in countries in this region: Nigeria, Democratic Republic of Congo, Ethiopia, Tanzania, Madagascar, Mozambique, Kenya and Uganda.

From 2020, we can make projections of global poverty based on forecasts of economic growth, the main driver of poverty reduction. In January 2020, before the COVID-19 pandemic, global poverty was expected to continue to decline to around 8%.

Proportion of the population covered by a work social protection program



Note : Calcul sur la base de moyennes simples des taux de couverture nationaux pour tous les groupe
revenu. La couverture réelle peut être plus élevée, car tous les programmes ne sont pas pris en compt
les enquêtes auprès des ménages de certains pays. On calcule le quintile le plus pauvre en se référant
niveau de bien-être avant transferts (revenu ou consommation) par habitant.

Given the economic contractions already recorded this year, such a forecast is no longer plausible. On the contrary, according to a conservative scenario, at least 88 million people will probably have fallen into extreme poverty in 2020, which would bring the global rate to 9.1%.

Under more pessimistic assumptions, over 100 million people may have been pushed into extreme poverty, resulting in an even higher global rate. Such an increase would negate three years of progress.

However, it should be kept in mind that these estimates have changed and will continue to change as countries face new consequences of the crisis and adopt different responses.

Assuming that the disruption caused by COVID-19 begins to ease in 2022, economic growth should return to a downward trajectory, but from a higher level than it would have been without the pandemic.

National poverty lines

In addition to extreme poverty, which is measured according to a single international poverty line, SDG 1 recognizes that countries can define their own lines according to local conditions. Target 1.2 aims to halve the proportion of people living in poverty, as defined by each country.

National poverty lines are often higher than the international benchmark of $1.90 a day, especially in rich countries. Poverty measured in this way is falling in most countries, but not fast enough: it is falling fast enough to meet the 50% reduction target in only a few countries. In many others, it is gaining ground.

Poverty, whether defined according to the international poverty line or a wider range of criteria adopted by different countries, remains a major global problem. The past few decades have seen remarkable successes in some countries and rapid reductions in global poverty, but sub-Saharan Africa is not following the same path. Demographic growth and the slow pace of poverty reduction make this region the one where extreme poverty is now concentrated. If the world is to achieve the poverty eradication goals in the foreseeable future, let alone by 2030, business as usual will not be enough.

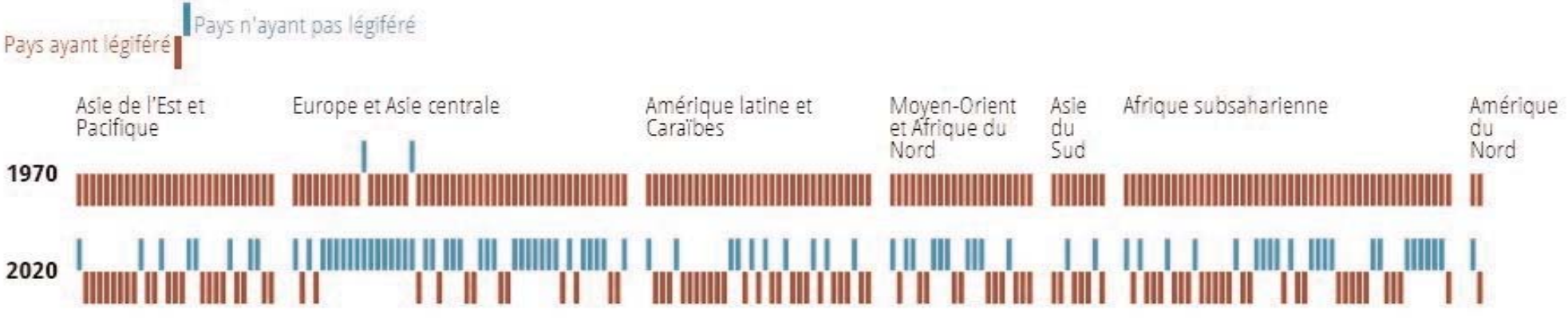
MEN AND WOMEN EQUALITY

Granting the same rights to women and men is fundamental to achieving gender equality. For generations, women's rights movements have fought to make equality a reality. For example, most women in the world today have the right to vote, which was not true a century ago. However, many other laws on which individuals' economic prospects and financial and social inclusion depend continue to treat men and women differently.

On a global scale, women are granted on average only three quarters of the rights granted to men. The World Bank's Women, Business and the Law Index provides data on SDG target 5.1, which aims to end all forms of discrimination against women worldwide and girls.

In 1970, for example, only two countries, both located in the Europe and Central Asia region, had enacted legislation requiring equal pay for work of equal value. In 2019, such a law was in force in 37 of the region's 49 economies.

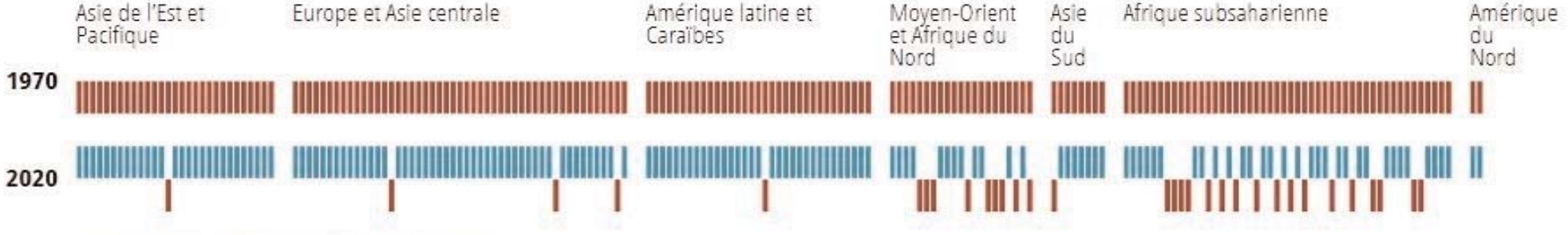
Does the law prescribe equal pay for men and women for work of equal value?



Source : Les Femmes, l'Entreprise et le Droit 2021

Toujours en 1970, aucun pays ne disposait d'une législation traitant spécifiquement de la violence domestique. Aujourd'hui, 158 pays sur 190 ont légiféré.

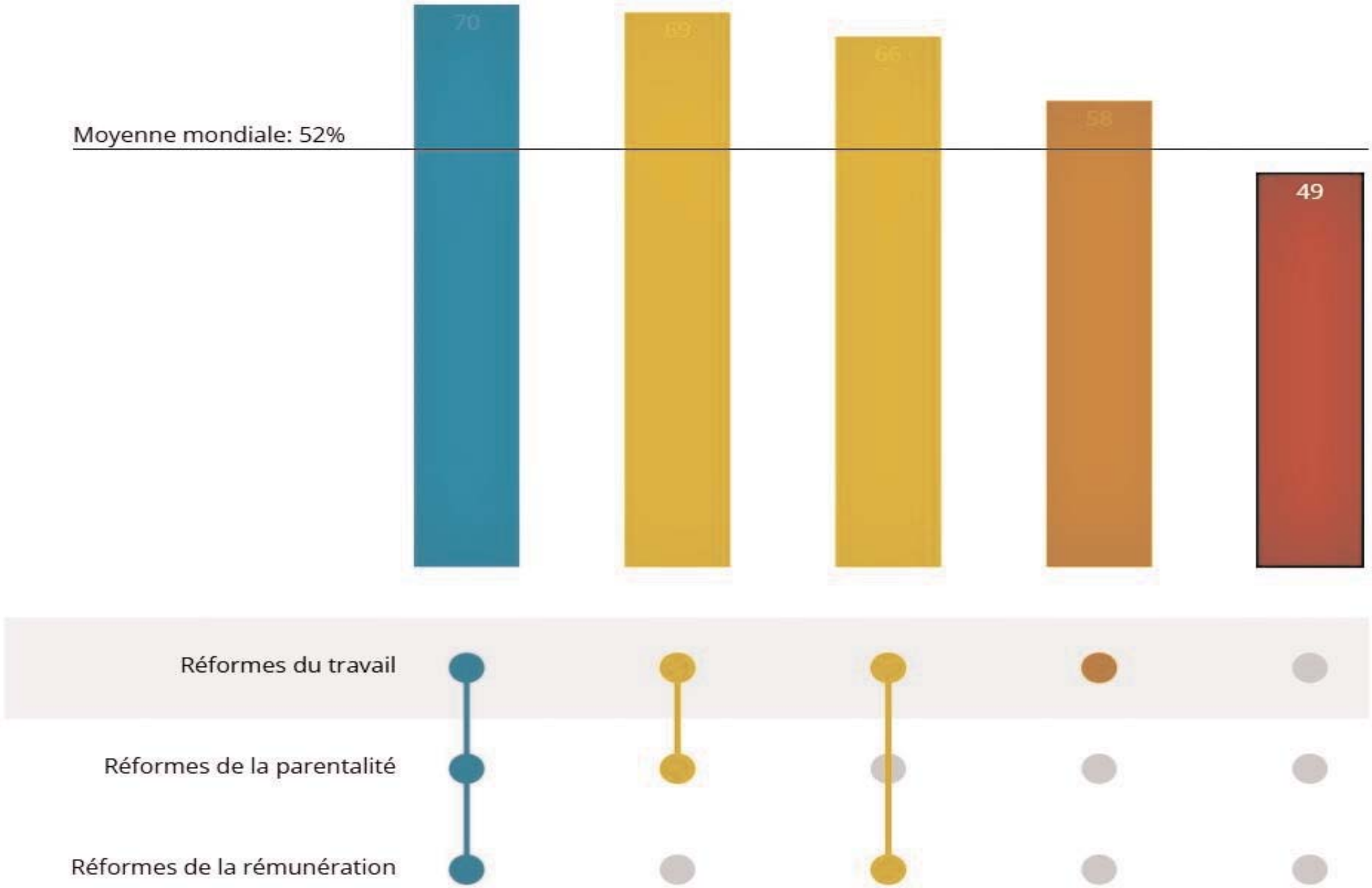
Is there a law specifically dealing with domestic violence?



Source : Les Femmes, l'Entreprise et le Droit 2021

Female activity rate according to reform schemes

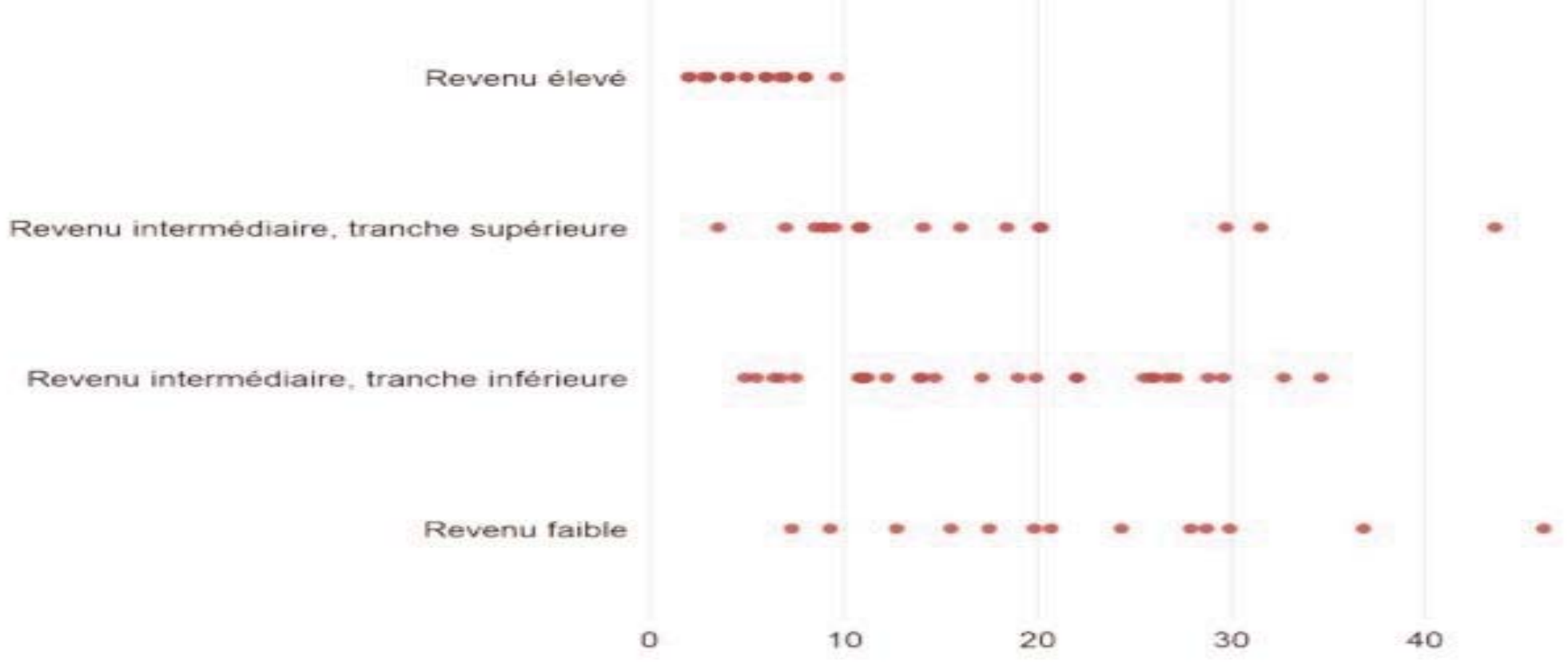
Taux d'activité des femmes en fonction de différents schémas de réforme (% de la population féminine âgée de 15 à 64 ans), 2019



Prevalence of violence against women is high in low- and middle-income countries

Les violences à l'égard des femmes peuvent avoir de graves répercussions sur leur bien-être mental et physique, et potentiellement affecter leur productivité et leurs revenus. Dans nombre de pays à revenu faible ou intermédiaire, la proportion de femmes ayant subi des violences physiques ou sexuelles au cours d'une année (cible 5.3 des ODD) était supérieure à 10 %. Toutefois, les données sur la violence à l'égard des femmes ne sont pas toujours disponibles.

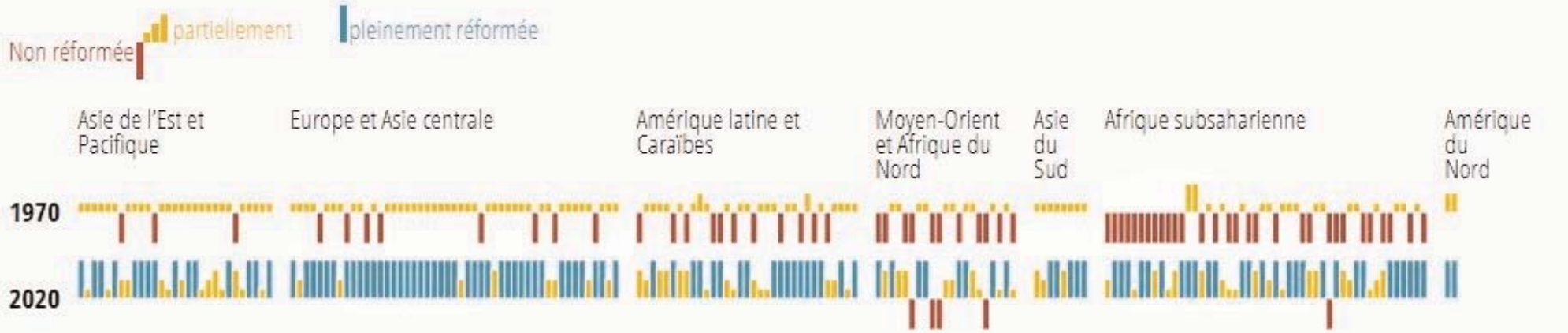
Percentage of women victims of physical and/or sexual violence (% of women aged 15-49)



Note : Les données du graphique correspondent aux valeurs les plus récentes entre 2010 et 2019. Données disponibles pour 81 pays seulement.

Source : Indicateurs du développement dans le monde (SG.VAW.1549.ZS)

Work

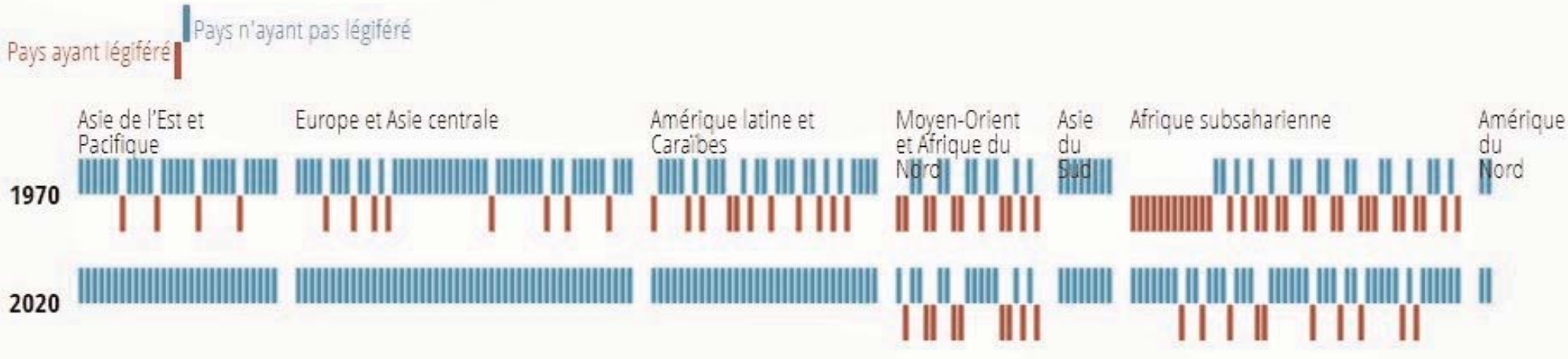


Source : Les Femmes, l'Entreprise et le Droit 2021

Les différents aspects juridiques liés à l'indicateur *Travail* sont détaillés ci-dessous.

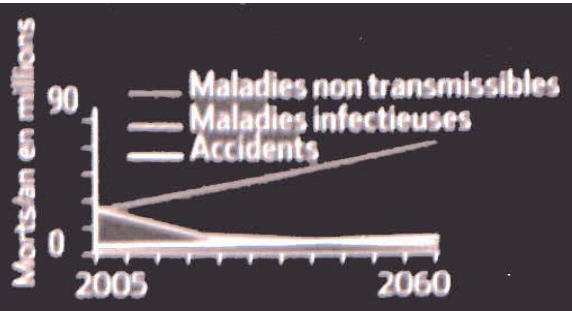
Obtenir un emploi	Discriminations à l'emploi	Harcèlement sexuel	Sanctions pour harcèlement

Can a woman get a job in the same way as a man?

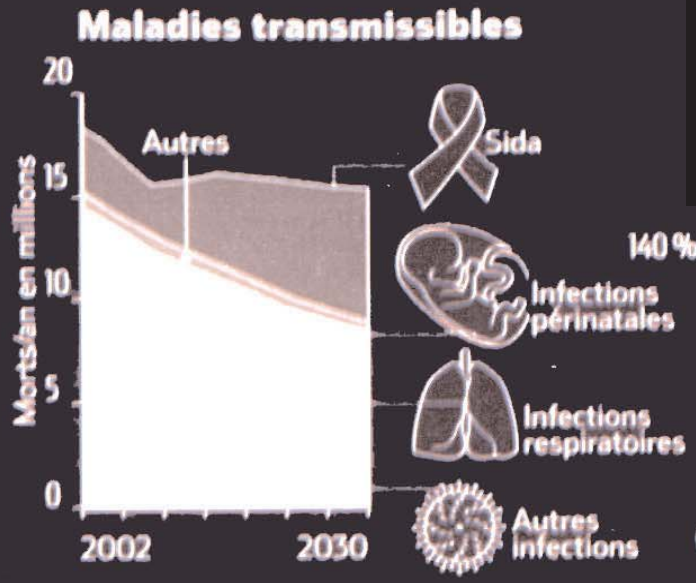


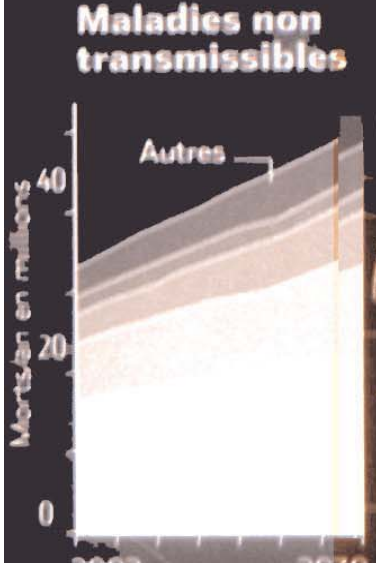
HEALTH

Non-communicable diseases will spread to the South



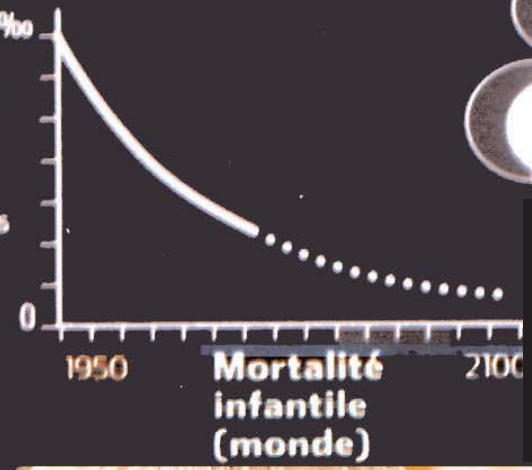
If mortality linked to infectious diseases continues to fall - they only cause 5% of deaths in 2060 - deaths due to non-communicable diseases (diabetes , cancer) will increase due to the increase in life expectancy and the westernization of the way of life of the populations of the South.





SAFER BIRTH

Infant mortality should fall thanks to better access to perinatal care in poor countries.



33%

This is the highest predicted infant mortality rate in the world expected in 2100 in Afghanistan

Annual deaths due to pollution forecast for 2050 against 1 million in 2000

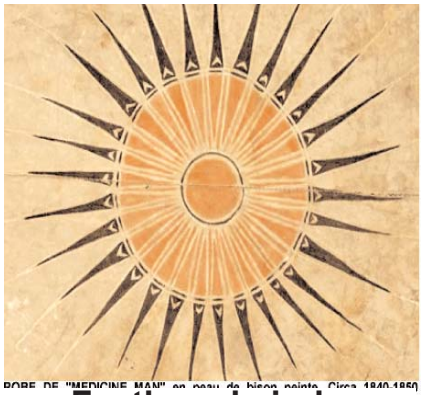
Medicinal knowledge disappears as indigenous languages die

By linking linguistic and biological information, the authors show that most indigenous knowledge of medicinal plants is linked to endangered languages, and that the loss of languages is an even greater danger to the survival of this knowledge than the loss of biodiversity. "Every time an indigenous language dies, it's like a library burning down, but we don't see it because it's silent."

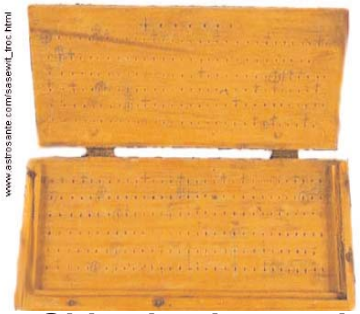
In the new study, researchers scoured the literature, including early records from colonizers, to map the uses of medicinal plants and indigenous languages in three regions: North America, the northwest Amazon and New Guinea. They found around 12,000 medicinal uses for more than 3,000 plants, known to people who speak 230 indigenous languages in these regions. But more than 75% of this knowledge resides in just one of these languages.

The United Nations lists all indigenous languages of the western Amazon as endangered, which also endangers the accumulated botanical knowledge of these groups. In North America, endangered languages account for 86% of unique knowledge about medicinal plants; the figure is 31% in New Guinea, according to the study.
The authors say that this knowledge begins to erode even before the languages disappear. In some groups studied, current speakers no longer recognize medicinal plants or do not know what mixtures to make and how to prepare them, with oral traditions, if you do not tell others while you are alive , all the teachings disappear.

In contrast to the high proportion of endangered languages, less than 4% of the medicinal flora of the three regions covered by the study is threatened with extinction. We are losing knowledge at a faster rate than biodiversity.
Indigenous cultures hold ancient knowledge beyond medicine. Indigenous languages encompass entire knowledge systems of biodiversity, social organization and environmental management
Without indigenous knowledge, valuable natural compounds that could generate medicines could be lost. Less than 5% of the medicinal plants used by the Ticuna people , whose ethnobotanical knowledge is among the best studied in the Amazon, have been examined for their biological activities. Additionally, adults were losing about 3% of their knowledge of plant uses each year, far more than estimated rates of overall biodiversity loss worldwide.



Feathered circle
Medecine man‘s dress



Old calendar used by medecine man

The loss of culture is also a loss of our ability to adapt and find solutions to growing environmental problems for example, how the indigenous peoples of Oaxaca in Mexico were able to develop ways to grow plants during droughts.

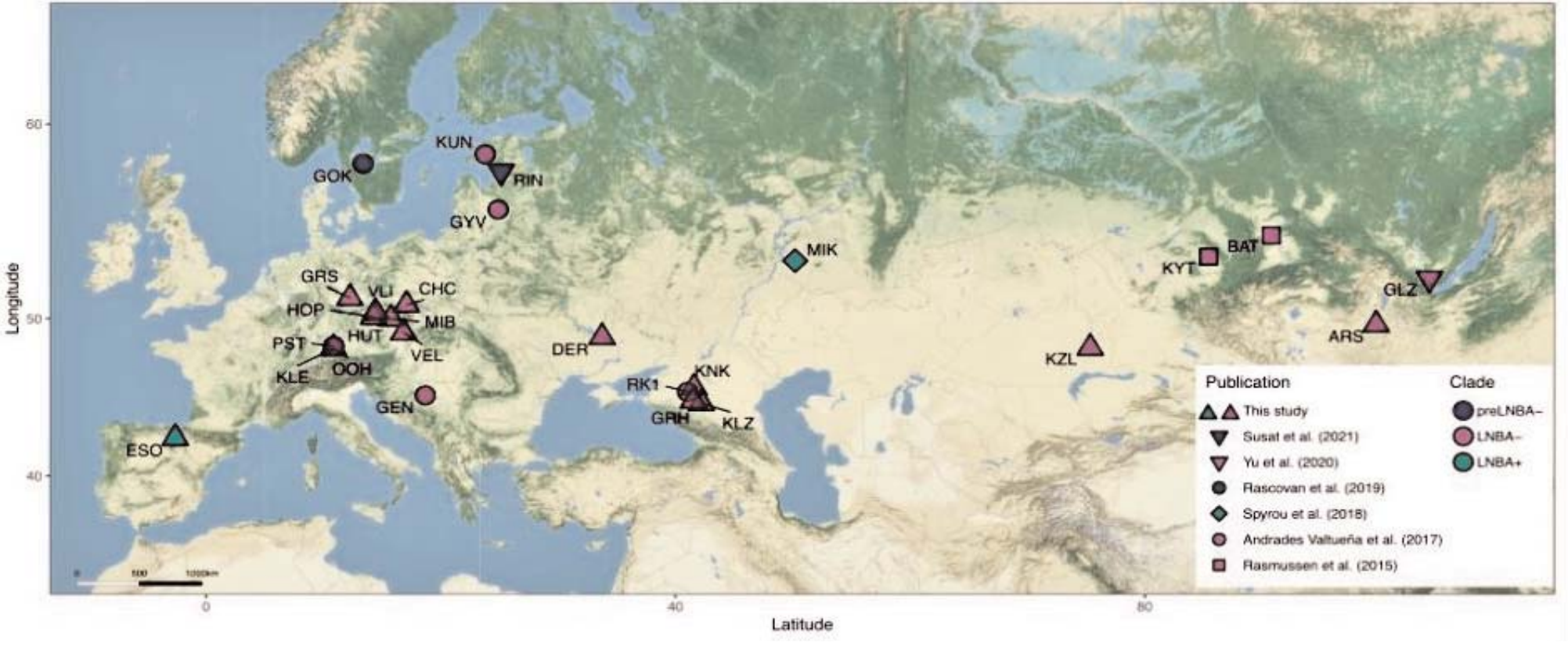
Threats to culture and the environment are two sides of the same coin. The complexity of medicinal plants is territorial knowledge. When you destroy a territory, you destroy nature, knowledge, our practices and our life.

Evolution, diversity and ecology of plague

The oldest known cases of plague date back around 5000 years. Analysis of the genomes of the bacterium Yersinia pestis suggests that the period between 6000 and 4000 years ago was critical for the evolution and ecology of this disease. Four ancient lineages of Yersinia pestis have been identified so far. They show that they can be genetically distinguished based on their adaptation to the flea, the main vector of plague today associated with rodents. Flea-mediated transmission of Yersinia pestis (bubonic plague) is either facilitated by blockage of the foregut (proventriculus), where the bacterium produces a biofilm, or independently of the biofilm, also called early phase transmission. The oldest form of plague presents a genetic profile which is incompatible with the transmission of the disease by the flea (LNBA-) although an ancient Russian lineage dating from the Bronze Age presents all the genetic adaptations necessary for transmission by the chip (LNBA+).

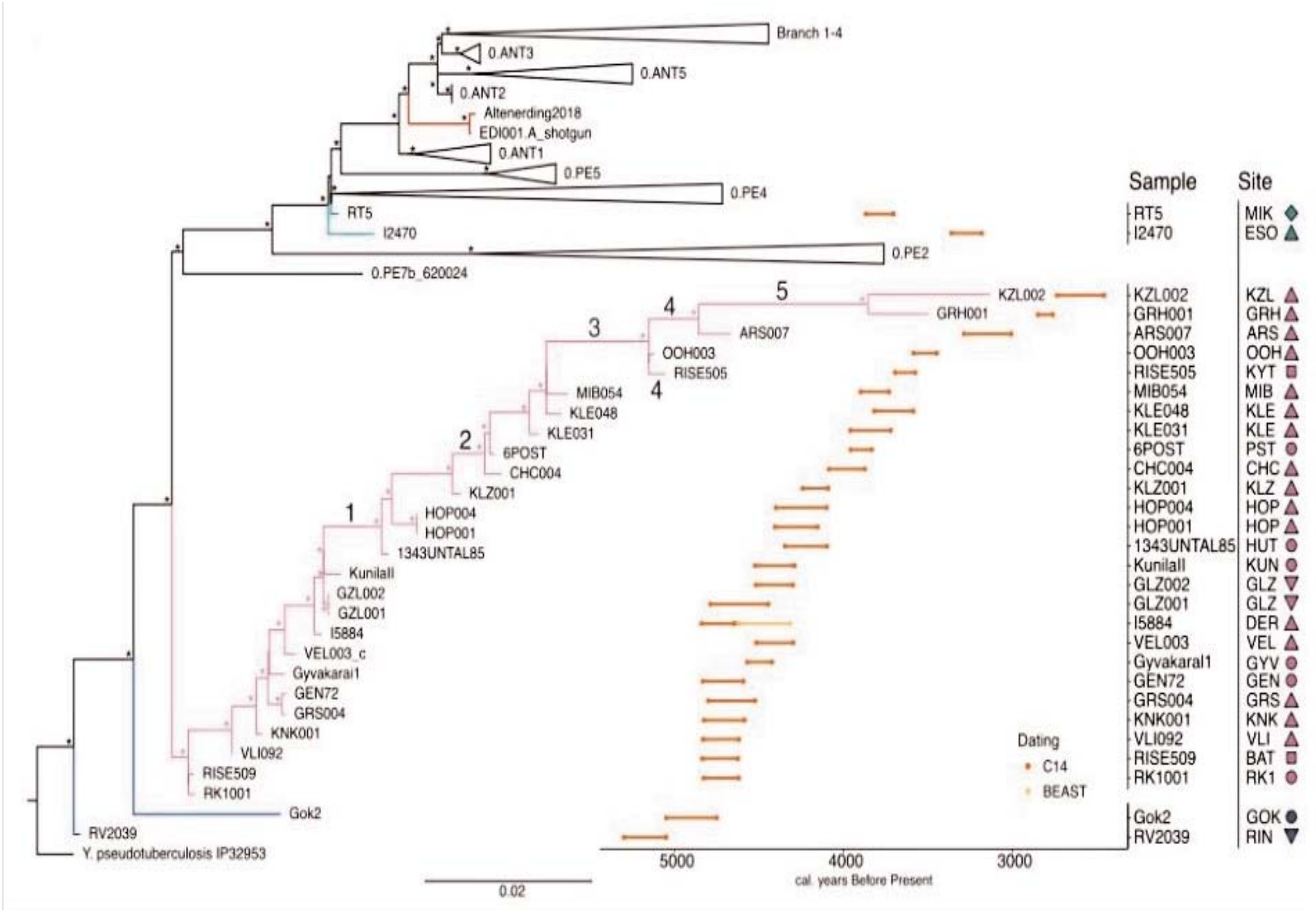
The absence of adaptation by the chip in certain ancient lineages suggests a complex transmission. Today some forms of plague are transmitted by droplets following close contact between humans: this is pneumonic plague. Changes in human behavior throughout history may have contributed to higher risks of infection by the bacterium Yersinia pestis, such as increased mobility and intensification of animal husbandry.

Paleo-geneticists have just published a paper entitled: Stone Age Yersinia pestis genomes shed light on the early evolution, diversity, and ecology of plague. They tested the genome of 252 ancient individuals from 15 archaeological sites in Eurasia dated between the late Neolithic and the Iron Age (between 5000 and 2000 years old). They thus highlighted the genome of the plague bacterium in 17 samples:



The authors reconstructed the phylogeny of the plague bacterium. Sixteen samples have a genome which indicates that there was no transmission by the chip (LNBA-). These results were added to those previously published to give the figure below:

The most recent sample of the LNBA- lineage is that from an archaeological site in Kazakhstan (KZL002) dated between 2736 and 2457 years in the middle of the Iron Age.



Interestingly a sample from Spain from the Bronze Age (I2470) belongs to the flea-borne lineage (LNBA+). It is also the oldest case of plague in the Iberian Peninsula dated between 3361 and 3181 years. On the phylogeny above, it is located apart from the genomes of the non-chip-transmissible plague, and close to the RT5 sample from Russia (Samara region). The latter is therefore probably the oldest example of bubonic plague.

The authors then analyzed the different virulence factors inscribed in the genome of the plague bacterium. Thus the Spanish sample has all the virulence factors, like that of Russia (RT5). All the new samples of the LNBA- lineage do not have the ymt gene important for the transmission of the disease by the flea. They also lack the YPMT1.66c gene, a virulence factor implicated in resistance to mammalian innate immunity. On the other hand, all samples newer than 1343UnTal85 lost the yapC gene. This event was followed by other gene loss events potentially linked to disease attenuations.

The oldest sample comes from an archaeological site in Latvia. it is dated 5300 years old. Next comes a sample from Sweden in the phylogeny. The two lineages LNBA- and LNBA+ appear then and seem to spread in parallel in Eurasia. The oldest lineage transmissible by chip is dated 3800 years in Russia. It now appears in Spain 500 years later and therefore indicates a wide geographical distribution of this lineage in Eurasia from the Bronze Age.

By similarity with the current cases, it can be assumed that for the old LNBA+ lineages of the plague, the fleas served as vectors of the disease and maintained the transmission of the bacterium in the populations of rodents. For the old LNBA lineages, the hypotheses are more difficult to formulate because they have no contemporary descendants. Non-human hosts and vector species remain to be determined. Rodents remain the species constituting the largest reservoir for diseases, but other species such as carnivores, domestic animals or birds may have served as hosts for the plague bacterium.

Who doesn't remember those history lessons evoking the plague epidemics in the Middle Ages? Behind all this hides Yersinia pestis, a bacterium that first attacks rodents before attacking humans. The disease most often existing in bubonic form (a bubo being an inflammation and enlargement of a ganglion), it can evolve into septicaemic plague and become more deadly and more contagious. In the history of humanity, its mortality is difficult to assess but it is very probably responsible for more than 100 million victims.

A coronavirus outbreak has occurred in East Asia 25,000 years ago, according to a genetic study

The genomes of multiple East Asian populations bear the signature of a viral epidemic that occurred around 900 generations ago, or 25,000 years ago (28 years per generation), according to a new study published in the Current Biology journal.

Throughout the evolutionary history of Homo sapiens, positive natural selection has frequently targeted proteins that physically interact with viruses, for example those involved in immunity or used by viruses to hijack the cellular machinery of host.

Over millions of years of human evolution, selection has led to the fixation of genetic variants encoding virus-interacting proteins (VIPs) at a rate three times higher than the rate observed for other classes of genes.

Strong selection on VIPs has continued in human populations over the past 50,000 years, as evidenced by the enrichment of VIP genes for introgressed Neanderthal adaptive variants as well as selective scanning signals (i.e. i.e. selection that drives a beneficial variant at substantial frequencies in a population), particularly around VIPs that interact with RNA viruses, a viral class that includes coronaviruses.

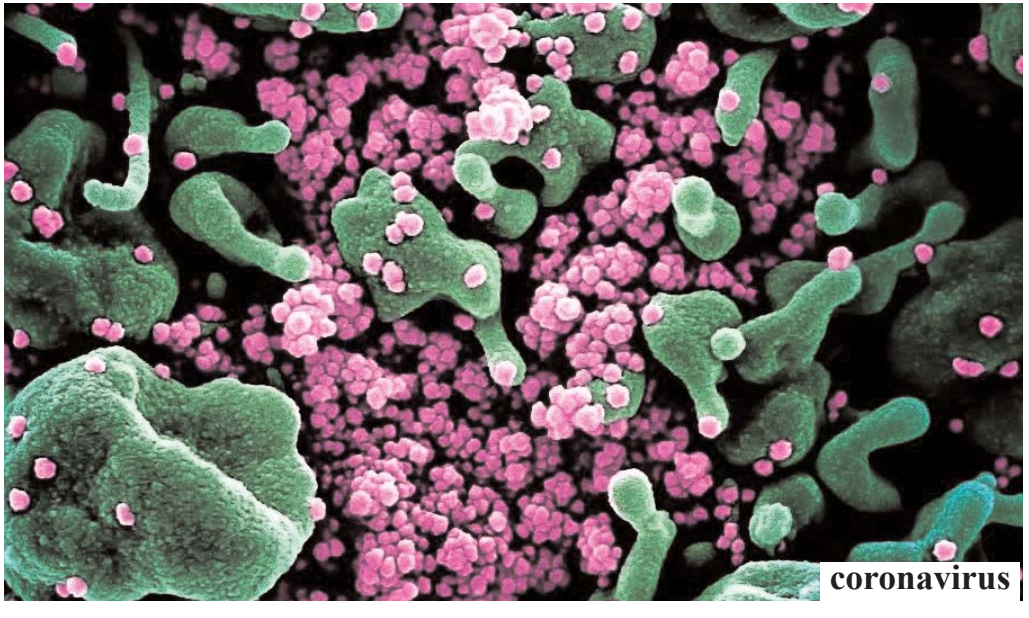
Accumulating evidence suggests that ancient RNA virus epidemics have occurred frequently throughout human evolution. However, scientists do not currently know whether selection has made a substantial contribution to the evolution of human genes that interact more specifically with coronaviruses. "The modern human genome contains evolutionary information stretching back tens of thousands of years, just as studying a tree's rings gives us insight into the conditions it experienced as it grew," said the Professor Kirill Alexandrov, researcher at CSIRO-QUT. Synthetic Biology Alliance and Center for Genomics and Personalized Health at Queensland University of Technology.

In the study, Professor Alexandrov and his colleagues used data from the 1000 Genomes Project, which is the largest public catalog of common human genetic variation. They examined whether selection signals are enriched in a set of 420 VIPs that interact with coronaviruses (such as SARS-CoV-2) in 26 human populations.

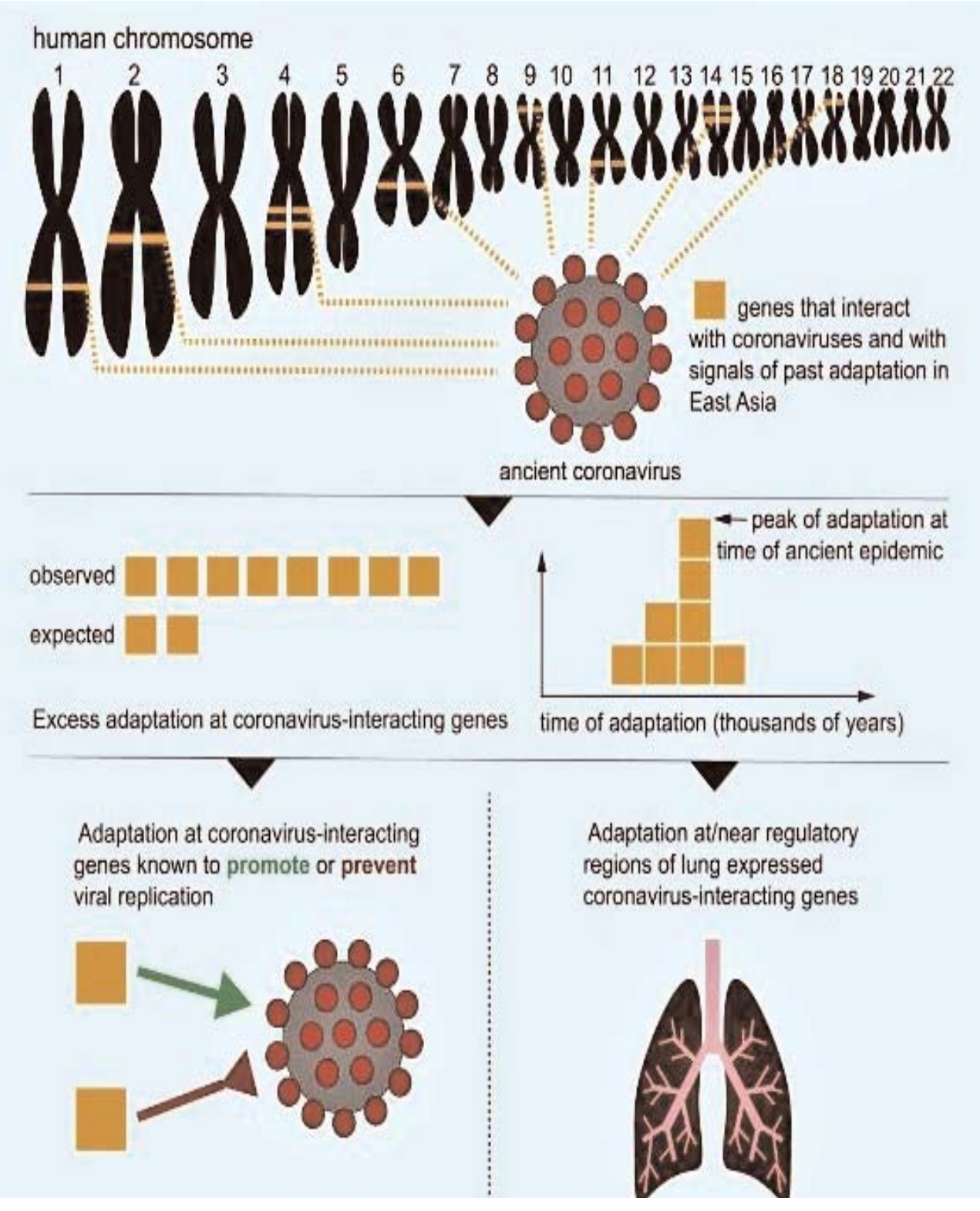
These coronavirus VIPs include 332 SARS-CoV-2 proteins identified by high-throughput mass spectrometry and an additional 88 proteins that were manually selected from the literature. Their analysis revealed a strong enrichment of scavenging signals in coronavirus VIPs in several East Asian populations, which is absent in other populations.

This suggests that an ancient outbreak of coronavirus - or another virus using similar VIPs - caused an adaptive response in the ancestors of East Asians.

The researchers found that 42 coronavirus VIPs may have been selected around 900 generations (25,000 years) ago and exhibit a coordinated adaptive response.



coronavirus


human chromosome
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
genes that interact with coronaviruses and with signals of past adaptation in East Asia
ancient coronavirus
peak of adaptation at time of ancient epidemic
observed
expected
Excess adaptation at coronavirus-interacting genes
time of adaptation (thousands of years)
Adaptation at coronavirus-interacting genes known to promote or prevent viral replication
Adaptation at/near regulatory regions of lung expressed coronavirus-interacting genes

"We applied evolutionary analysis to the human genomic dataset to uncover evidence that ancestors of East Asian peoples experienced an outbreak of a coronavirus-induced disease similar to COVID-19" , said Professor Alexandrov.

"During the epidemic, selection favored human gene variants linked to pathogenesis with adaptive changes presumably leading to less severe disease."

"By developing a better understanding of ancient viral enemies, we understand how the genomes of different human populations have adapted to viruses that have recently been recognized as an important driver of human evolution."

"Another important consequence of this research is the ability to identify viruses that have caused an epidemic in the distant past and which may do so in the future."

"This basically allows us to list potentially dangerous viruses and then develop diagnostics, vaccines and drugs if they come back."

SRAS 2 - COVID

From the savannah to the boreal forest, thousands of viruses circulate "silently" among hundreds of animal species. Of the lot, at least 10,000 viruses could infect humans, but the opportunities to jump from their species to ours are lacking. Climate change should, however, give everyone the opportunity to meet and exchange viruses, according to a study published last week in the scientific journal Nature. Based on massive numerical modeling of 3,100 species of mammals, the researchers estimate that around 300,000 "first encounters" will take place between species that don't normally interact, resulting in around 15,000 "viral spillovers" of 2070.

Some places will be particularly conducive to meetings. Animals fleeing the heat, for example, will tend to climb in altitude. Thus, two species living on either side of a mountain range could meet at the end of their ascent. Some species will also have a disproportionate effect. Since they fly, bats - which are also an important viral reservoir - will be able to move more quickly to adapt to climate change. They will account for the majority of viral exchange, believe scientists led by Colin J. Carlson, of Georgetown University, Washington DC

Even if it does not concern Homo sapiens at first, each viral exchange increases the possibility of creating "bridges" that can help viruses reach us in the end. It should be added that the risks highlighted in the study are only part of the problem: the modeling does not include birds or pathogens other than viruses.

The climatic multiplication of viral overflows would already be the work. In an interview with The Atlantic, virologist Vineet Menachery points out that the new publication in Nature indicates that the high frequency of viral outbreaks observed in recent decades is not an anomaly, but rather "what we should expect, and which could even accelerate".

"It's a little pretentious to say that a vaccine is the solution to the current crisis. Viruses are here to stay and it's a lesson in humility that we predators get from these tiny beings who are at the basis of everything on Earth. As predators, we must change our view of nature and rethink the place of humanity on the planet to find a lasting solution to this cohabitation", says the oceanographer, who points out that, in the sea , viruses also act as regulators of species and bacteria when an ecosystem is threatened.

Prepare for peace, not war

"The vaccine is the weapon of redemption, but I hope that we will let go of the victorious speech, and that this will not be a reason to ignore nature and not prepare for the next epidemic. ", warns the scientist. Humans believe they are all-powerful, but microbes were there and built life long before us. Bacteria own us, not the other way around. They have control over our body, our digestive system, our reproductive system and even our brain?" he says. It's a bit pretentious to say that a vaccine is the solution to the current crisis is not sanitary, but first and foremost environmental.

Completely inherited from the overexploitation of animal resources by man and his lack of respect for other species. "If we want to avoid becoming host to these viruses that are destructive to humans, we must preserve the habitats of other species. If they bother us, it is because by destroying biodiversity, we have made their habitats disappear. natural hosts and that they [viruses] now greatly need us to reproduce." More than a painful environmental wake-up call, the current crisis also reveals an immense social wound, devastated by the immense impact of the pandemic on the elderly.

Perhaps because we close our eyes to the reasons (Don't Look Up moment) or because it sends us back to our own animality, we often forget that we share with nonhuman animals many viruses, parasites and bacteria. Sometimes this happens without too much difficulty; sometimes it triggers epidemics and pandemics.

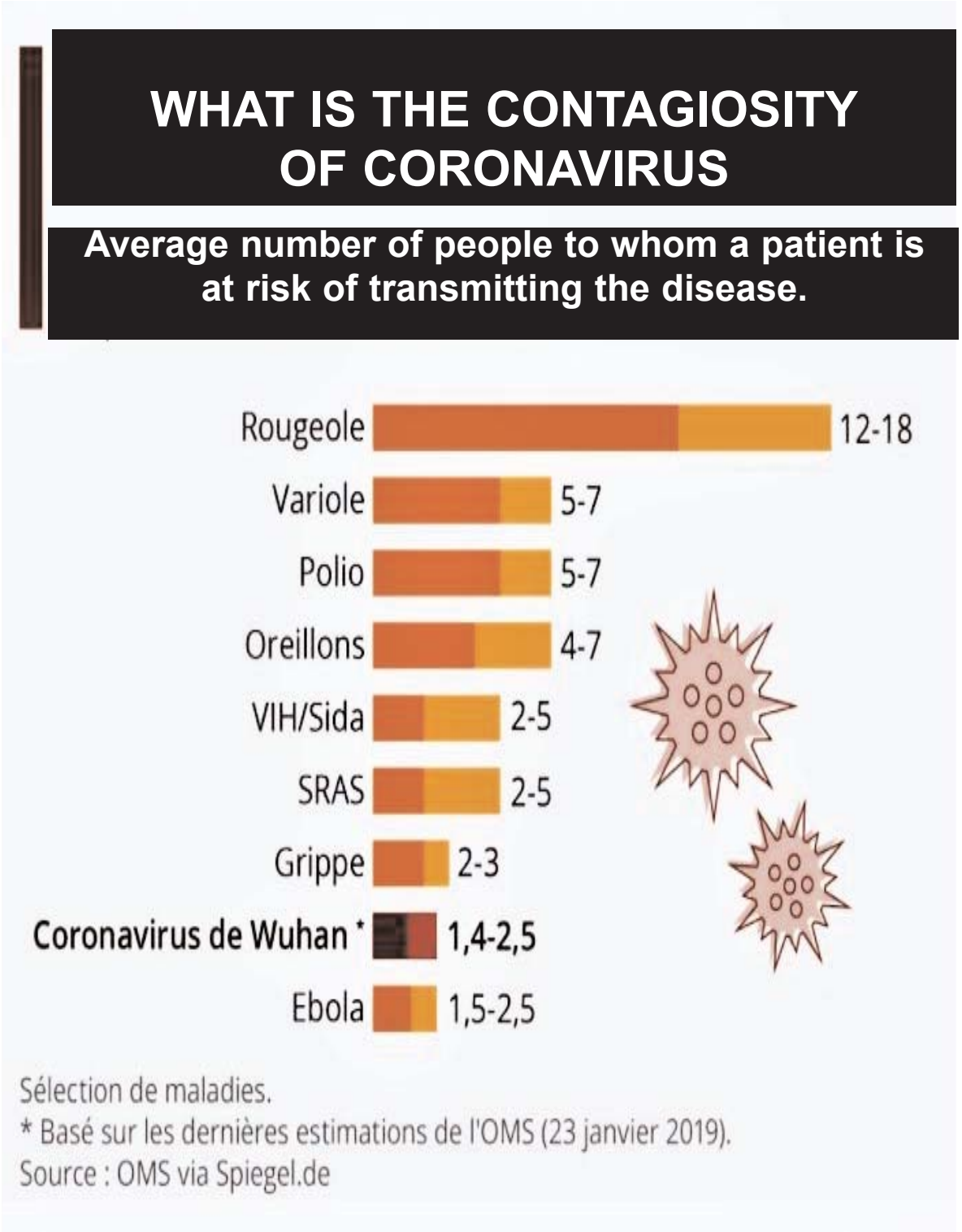
The World Health Organization (WHO) estimates at almost 60% the number of emerging diseases of zoonotic origin (ie of non-human animal origin). This figure has been increasing for fifty years. In question? Global changes.

Climate change in the first place, which pushes wild species to migrate. But also deforestation and overpopulation, which create unexpected and more frequent contact between humans and wild animals and which, by attacking biodiversity, suppress what is called the "dilution effect", supposed to temper the risks. of infection between animal and human species, as well as the overconsumption of antibiotics in intensive farms where antibiotic resistance is developing.

Viruses such as influenza, but also many others such as HIV, Ebola, Zika, SARS and SARS-CoV-2 at the origin of Covid-19, have all been transmitted from animals to humans. human to then spread massively and create the tragedies that we know.

In addition to zoonoses (known as spillover), there are also reverse zoonoses (also called spillback), when humans transmit the infectious agent to animals. Fundamentally, researchers are unsure whether the two processes are similar and comparable, and few events have been counted overall. The fact remains that for SARS-CoV-2, the World Organization for Animal Health has been able to identify a certain number of cases of transmission from human to animal, even if the reported figures remain extremely low in view of the intense circulation of the virus over the past two years - transmission remaining essentially human-to-human.

As of March 31, 2022, 669 epizootic outbreaks (this is what animal epidemics are called) had been reported. They affected twenty species in thirty-five countries. Among the infected animals, domestic carnivores (cats, dogs, ferrets and hamsters), farm animals (mink) and

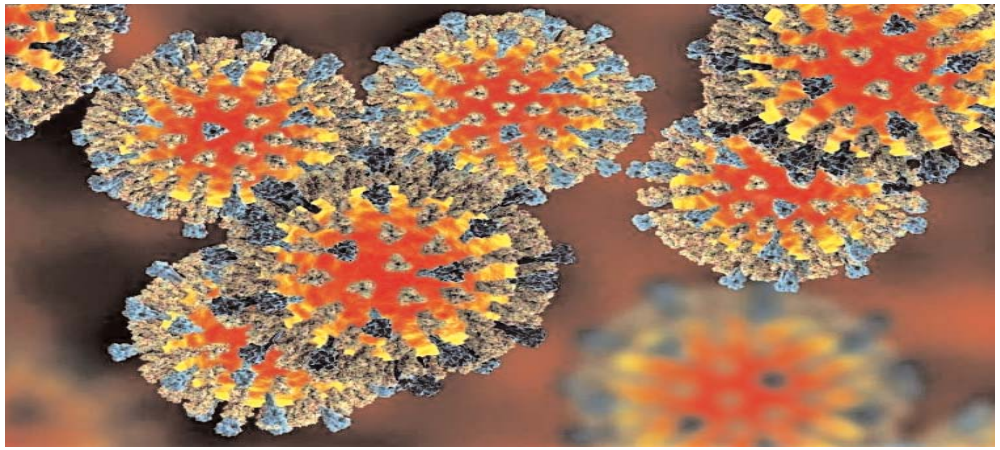

WHAT IS THE CONTAGIOSITY OF CORONAVIRUS
Average number of people to whom a patient is at risk of transmitting the disease.
Rougeole 12-18
Variole 5-7
Polio 5-7
Oreillons 4-7
VIH/Sida 2-5
SRAS 2-5
Grippe 2-3
Coronavirus de Wuhan * 1,4-2,5
Ebola 1,5-2,5
Sélection de maladies.
* Basé sur les dernières estimations de l'OMS (23 janvier 2019).
Source : OMS via Spiegel.de

and non-captive wild animals (fallow deer, deer, mice) and captive animals (in particular panthers and lions living in zoos).

Farm animals seem, for their part, relatively spared. Admittedly, cattle, sheep and pigs are receptive, but chickens and several other species of birds are neither receptive nor susceptible to SARS-CoV-2, despite their propensity to contaminate themselves with viruses. flu.

Subvariants and immune deficiency
It should also be noted that the human coronavirus has been able to be transmitted between animals of the same species, as was the case in farmed mink in Denmark or in white-tailed deer, of which there are 30 million individuals living in in the wild in North America and in which an estimated 40% have been infected with human SARS-CoV-2. The epidemiological role played by animals in the spread of SARS-CoV-2 is not fully understood. If pet carnivores (dogs, cats, ferrets) can be considered as "epidemiological dead ends" for the transmission of SARS-CoV-2, the same is not true for farmed mink and the hamsters. It is necessary to distinguish what is called an "animal reservoir" from an "amplifier host". For the moment, apart from Rhinolophus bats - which, by harboring human coronavirus precursors without showing clinical signs, are real reservoirs for SARS-CoV-2 - no other animal has been identified as a reservoir.

MEASLES



The good old measles virus would have passed to humans more than 2,500 years ago. To establish this date, virologists from the Robert Koch Institute in Germany went to dig into the collection of lungs at the Museum of Medical History in Berlin. Among these organs fixed in formalin, they selected that of a patient who died of measles in 1912 - the oldest measles virus genome ever analyzed - and reconstructed the phylogenetic tree of the virus by comparing it with other current and animal viruses.

It has long been known that the human measles virus originates from a related virus that infects cattle and sheep. But it was estimated so far that its passage in humans dated from the 11th or 12th century AD. back more than 1,000 years. The researchers observe that the emergence of measles in humans coincides with that of cities with several hundred thousand inhabitants in China, India, North Africa and Europe. Which seems logical: in small communities, the virus quickly arrives in a "dead end", having no new host to infect.

The story sounds like a disaster movie script. It is however reported by a very serious scientific study published in the journal JAMA Pediatrics on July 30, 2018. When in March 2013, a young American returned to New York for the holidays, he did not suspect that he was on to the point of causing the biggest measles outbreak the city has seen in 20 years. The young man then studied in London, where he contracted the disease. Belonging to an Orthodox Jewish community where most members are not vaccinated for religious conditions, he quickly contaminates those around him and the places he visits. Between March 13 and June 9, 2013, no less than 3,351 people will come into contact with the virus, according to the JAMA Pediatrics study, of which 58 people contract measles. This disease is indeed extremely contagious, being transmitted by the projection of salivary or respiratory droplets, when you cough or sneeze. A single person can easily infect 15 to 20 others, sometimes even before developing symptoms. This will undoubtedly remind you how and why a certain Sars-Cov-2 spread so quickly.

CHORELA

In 1832, cholera made its first appearance in France: the epidemic first affected the northeast of the country then in March, the first cases were reported in Paris. The violence of the disease and its ignorance on the medical level, will deeply traumatize the French. In public opinion, the specter of the great mortalities of the past resurfaces, while doctors affirm that France is now safe from any deadly epidemic, given the progress in hygiene and the preventive measures put in place. at borders and at ports.

From March to September 1832, the infection (a bacterium) caused the death of 18,400 people in Paris, increasing the number of deaths recorded annually from 25,500 to more than 44,000. On the whole of the French territory, more than 100,000 people are mowed down by cholera. The pandemic, which originated in Bengal (under the administration of the British crown), moved away from France in 1834, after causing havoc in the south of the country, particularly in Provence.

In 1846, a new outbreak of a global epidemic broke out in China: cholera arrived in Europe via England and in France, via the port of Dunkirk in November 1848. The "cholera vibrio" which had not yet been discovered , is spreading through the departments of Pas-de-Calais, Somme and Nord. It is soldiers already affected and moved from Lille to Paris, who bring the contagion to the Paris region. Cholera devastates the capital.

Cholera quickly affected the northern suburbs of the capital: the first death was officially recorded in Paris on March 7, 1849. Death, which occurred in half of the cases, was observed within forty-eight hours of the appearance of the first symptoms. . Mortality intensifies sharply in May, peaks in June when the weather is very hot; the epidemic ceases during the month of October. In Paris, there are 19,184 deaths due to cholera, including 10,950 at home; people affected represent approximately 3.5% of the Parisian population. As in 1832, all age groups are concerned, but young children and the elderly are at greater risk. Medicine is unable to stop the progression of the disease and limit its effects.

In Paris, but this remains valid wherever cholera strikes, the social nature of the epidemic seems obvious: the counting of deaths by neighborhood indicates significantly higher mortality rates in working-class neighborhoods than in wealthy sectors. Same observation as in 1832: studies on the ravages of the epidemic show that the poor die more than the rich; the geography of cholera merges with that of poverty. In 1832, the social classes accuse each other: the bourgeois denounce a disease of the people which threatens them by contagion and the workers accuse the authorities and the government of attempted poisoning aimed at eliminating them. In 1849, the epidemic aspect of the disease, which is raging worldwide, is no longer disputed and it is accepted that it can affect everyone, escaping all human manipulation.

Contagion or infection?

Since 1832, a debate has agitated doctors and the French administration: is cholera a contagious disease or an infection? The importance of the question is such that beyond the medical aspect, the discussion has political implications. Major deadly epidemics have not affected France since the plague in 1720, but the principle of contagion has been imposed since the Middle Ages. As soon as an epidemic is reported abroad and can enter French territory, protective measures are taken to isolate those affected in order to prevent the spread. The cholera pandemic which spreads from 1830, causes a controversy among doctors about the contagion or infection. The retained idea of "miasmas" proliferating in the air and contaminating

subjects predisposed to contracting cholera, will develop rapidly. The debate is all the more lively as the new theory, which lacks scientific credibility, makes it possible to lift all the protectionist measures (in particular at the borders) which hinder international trade. It also makes it possible to avoid any segregation between wealthy and poor classes.

Unsanitary conditions, cause of infection?

During the epidemic of 1832, the statistics relating to cholera in Paris reveal a real geography of the disease and affirm the link between misery and death. These findings are in line with the fears of "hygienist" doctors about the unsanitary conditions of dwellings. The French doctor Louis Villermé recognizes like a majority of his colleagues, that the spread of "miasmas" is favored by the lack of hygiene (existence of slums) and overcrowding. The good health of populations therefore depends on a healthy lifestyle in sufficiently ventilated housing, where bodily cleanliness must be the rule, as well as sufficient and healthy food. Such living conditions presuppose an ease and an education which are precisely lacking in slums! The diagnosis seems to have been made and the demands for a political response are becoming urgent; the doctors denounce the threat of the slums but the cleansing of authority of whole districts is not feasible. In Paris, the highest mortality rates are found, as in 1832, in the most disadvantaged neighborhoods in terms of hygiene.

Social surveys confirm the importance of the environment and in particular of housing on health. With the approach of the second cholera epidemic in 1849, we are interested in the populations crammed into unsanitary housing in order to slow down the spread of the epidemic as much as possible. It is urgent to legislate: the law voted in April 1850, recognizes the principle of insalubrity and encourages measures of installation which lead to the destruction of hearths of infection (demolition of old hovels).

Alongside the contagion / infection debate, the notion of public hygiene triumphs, with the idea that "miasmas" can be propagating agents of cholera and that they circulate particularly in unhealthy places. The controversy between defenders of contagion and those who believe that the disease results from an infection, is not yet based on any scientific basis. Practitioners have already mentioned at the beginning of the 19th century, the possible existence of microorganisms at the origin of cholera disease. The bacterium responsible for cholera (Vibrio cholerae) was discovered in 1854 by the Italian anatomist Filippo Pacini and isolated in 1884 by the German doctor Robert Koch who demonstrated the role of water as a trans-

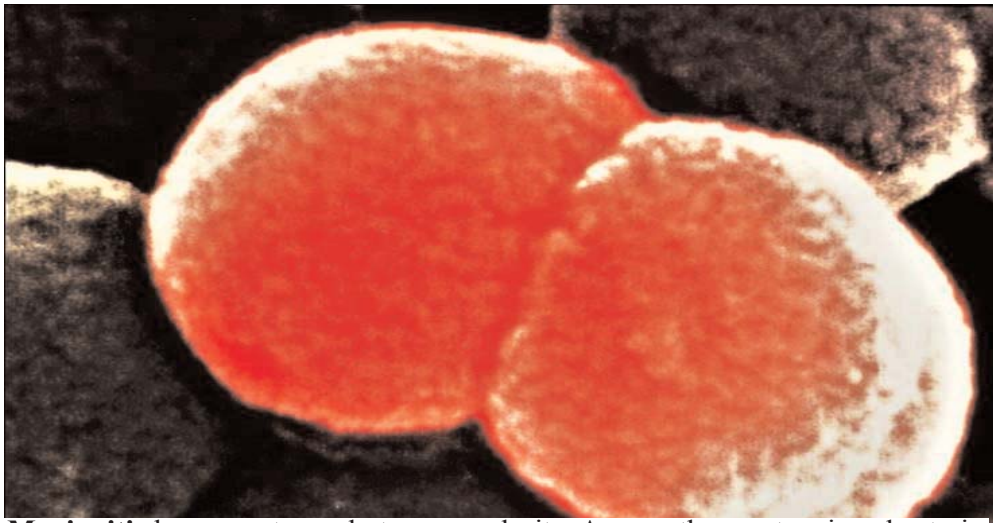
mitter of the disease.

Viruses or bacteria, each of these serial killers follows its own protocol. Some prefer quantity: their universality inevitably causes victims among the people they infect. Others prefer quality: they infect little but the chances of their hosts surviving are very slim. Between the two, there is a whole range of possibilities.

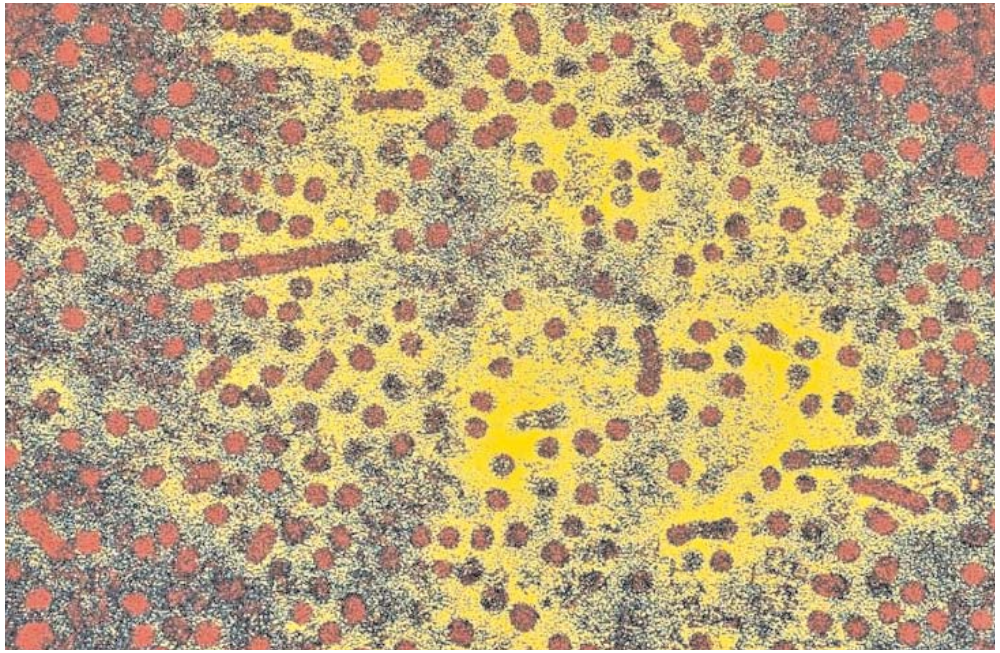
There is also the choice of weapons: blocking the immune system (like HIV), attacking vital organs (like the H5N1 flu) or paralyzing its victim like botulinum toxin does. These viruses and bacteria are therefore all different but pull in the same direction towards a common objective: to kill humans. It's up to him to react.

Contagious virus: what are the modes of transmission?
Contamination by a virus is generally through droplets of saliva from coughing, sneezing, or during close contact with a patient. It can also be done via objects contaminated by secretions from the nose or throat (toys, handkerchiefs, etc.). Other viruses are spread through sexual or blood contact (HIV), bodily fluids (Ebola) or through an insect (Zika, dengue fever). Unfortunately, it is during the incubation phase, when the symptoms are not yet visible, that the risk of contagion is highest. This incubation period lasts between six and 14 days depending on the virus and the individual.

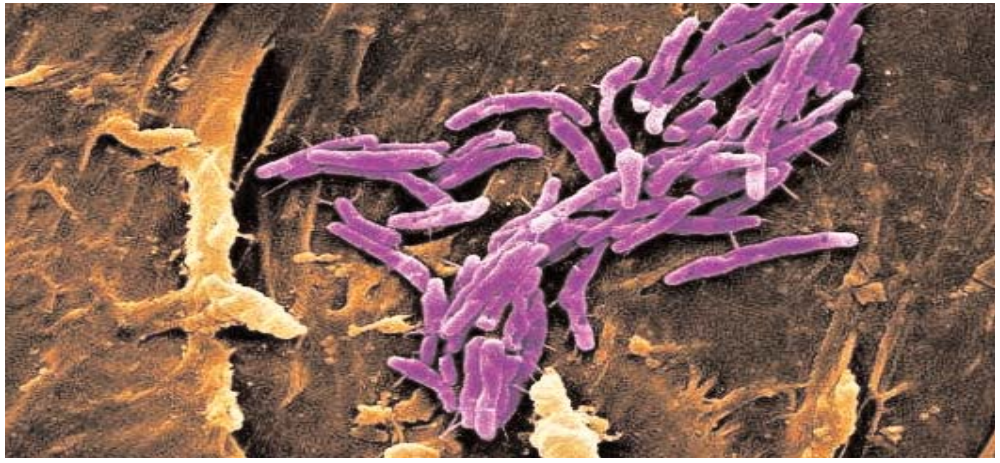
Staphylococcus aureus is not an inherently dangerous bacteria for mankind. Most of the time, it only causes small mild infections. But this sneaky woman sometimes hides in hospitals, and takes advantage of a lesion to insert herself into a weakened patient to colonize him and cause sepsis. There is always time to subject her to antibiotics... but she is showing herself to be more and more insensitive to the drugs that are opposed to her and is developing a growing resistance!



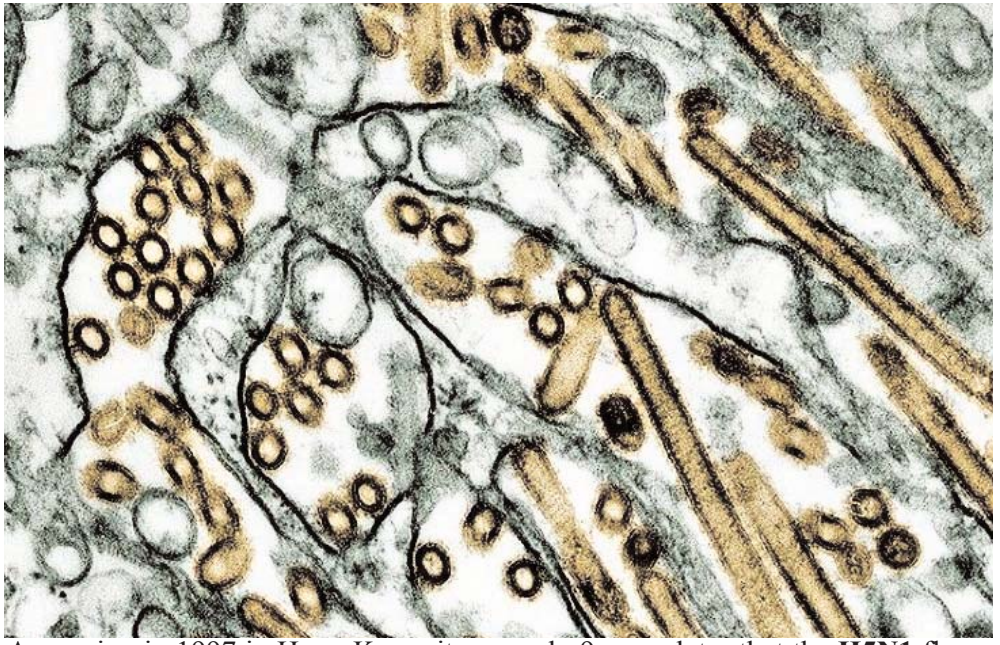
Meningitis knows not one, but many culprits. Among the most serious bacterial forms, the main culprit is Neisseria meningitidis, involved in 90% of cases. If there were no treatments, the infection would almost certainly be fatal. Despite antibiotics, one in five newborns and one in four adults succumb to this infection of the meninges.



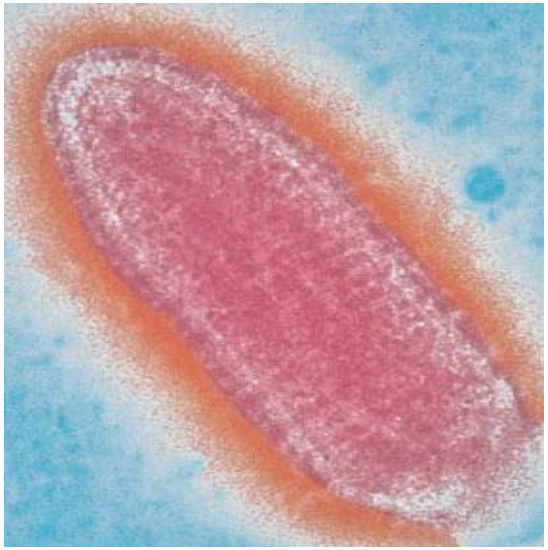
We talk about it less than HIV, yet it deserves our full attention. **The hepatitis B** virus is transmitted a hundred times better than the AIDS virus during sexual relations and then attacks the cells of the liver. Most often, the disease does not progress much and the patient does not feel anything. But sometimes, hepatitis becomes chronic, as in more than 300 million patients, and gradually destroys liver cells, leading to cirrhosis or liver cancer, which is very difficult to treat.



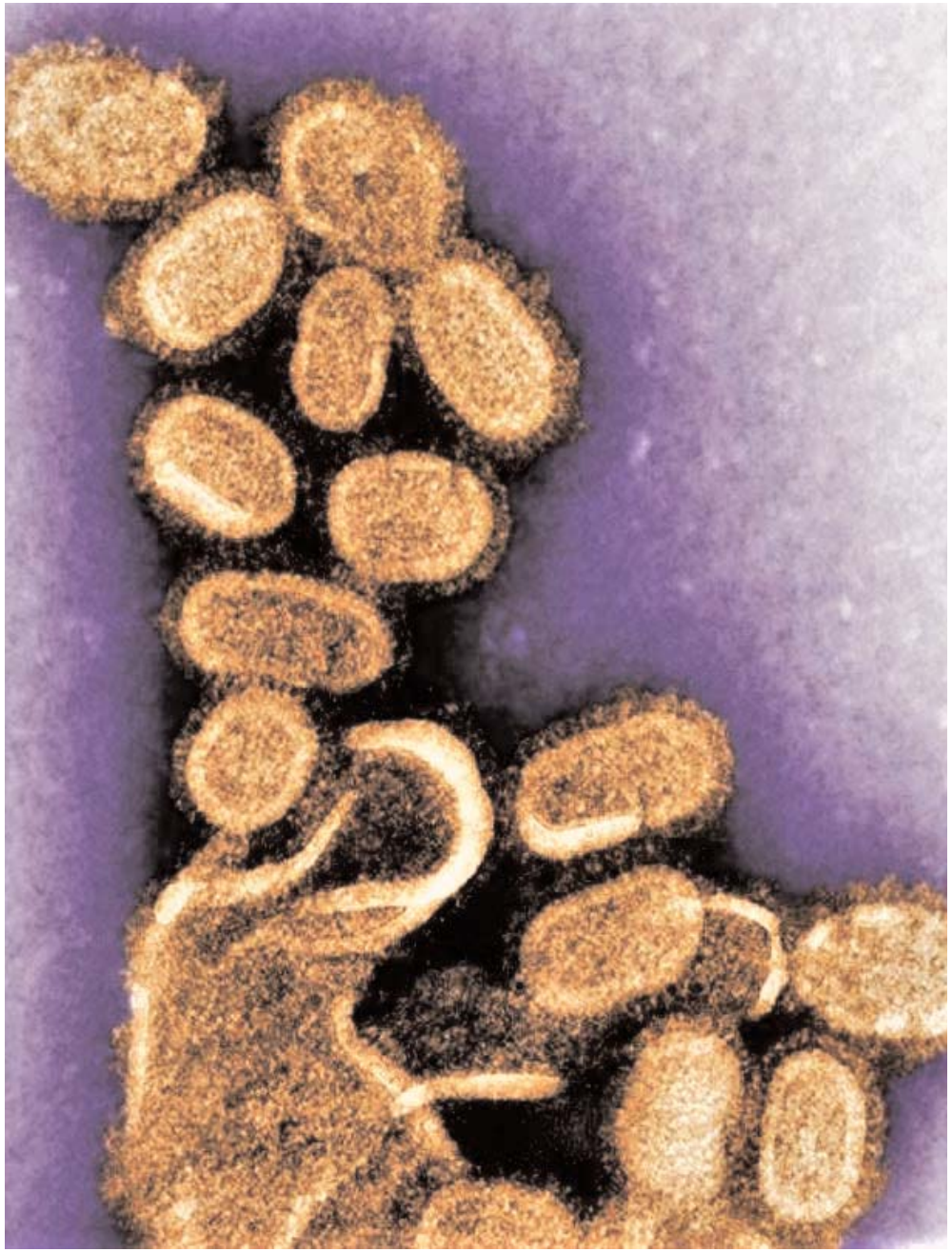
Having become rare in rich countries since the introduction of BCG, **tuberculosis** nevertheless continues its murderous work throughout the world. In 2010 alone, the bacterium responsible, Mycobacterium tuberculosis, infected 8.8 million people and killed 1.4 million of them, attacking their lungs. The bacterium has been around for 3 million years.



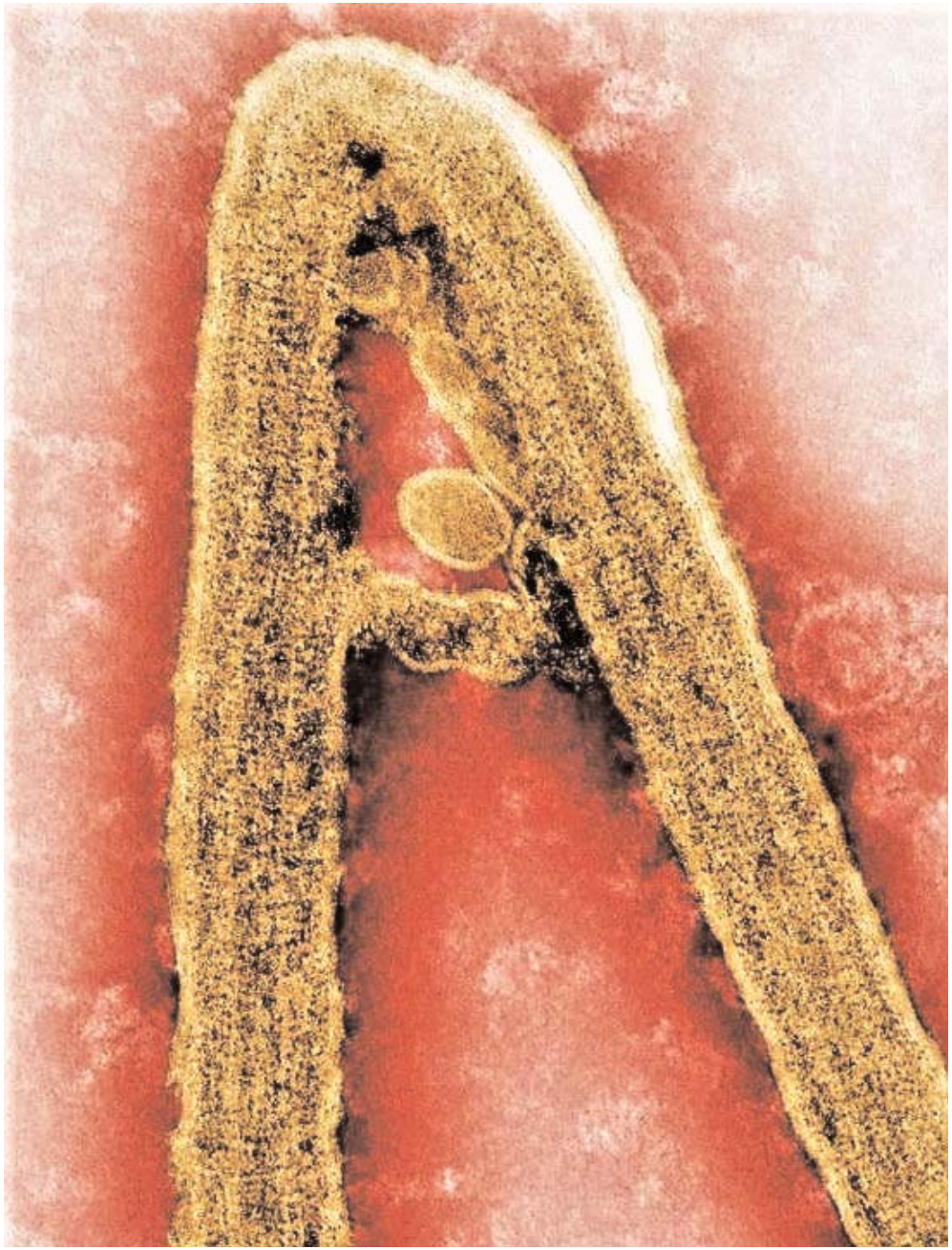
Appearing in 1997 in Hong Kong, it was only 9 years later that the **H5N1** flu caused the whole Earth to panic. The virus (here in gold in dog cells), transmitted to humans only by infected birds, is fatal in 60% of cases. In August 2012, the WHO counted 608 people who had contracted the virus since its inception, for 359 deaths, even if many mild or asymptomatic cases could not have been counted. Scientists nevertheless remain worried, because the pathogen is still circulating in nature and we know that a few mutations could be enough for it to become contagious in the human species. In this case, the deaths could be counted in the millions...



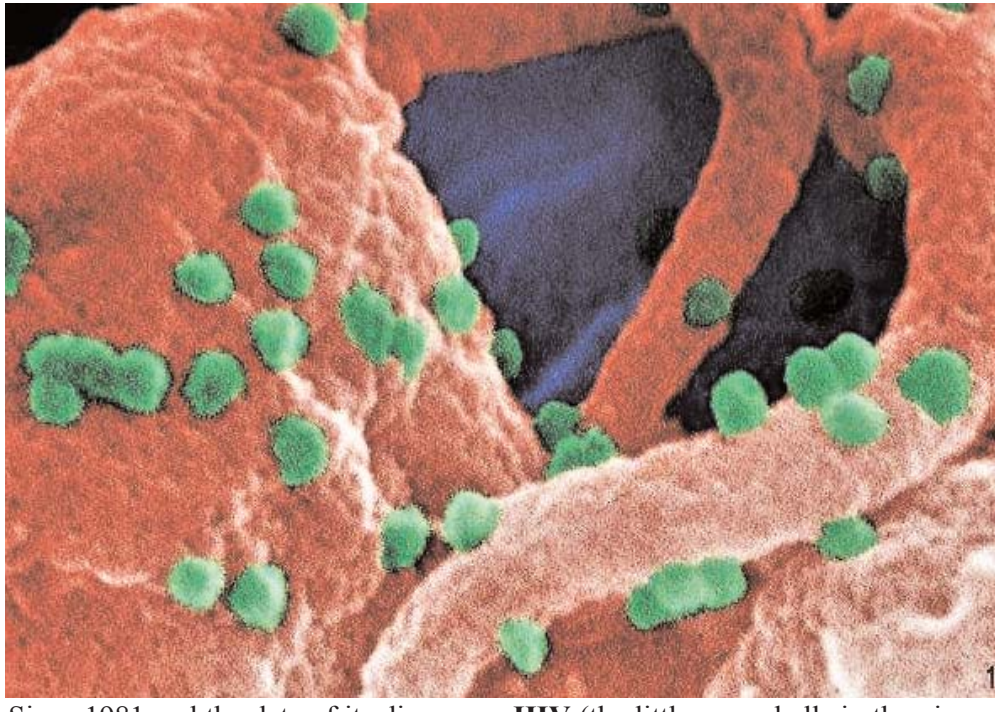
Thanks to the work of Louis Pasteur, rabies has clearly declined in the world. There are still more than 50,000 human deaths on the planet in 2004 because of the virus of the **rhabdoviridae** family. Transmitted by bite, it rushes straight into the nervous system and wreaks such havoc that death is almost inevitable. Fortunately, the vaccines are there!



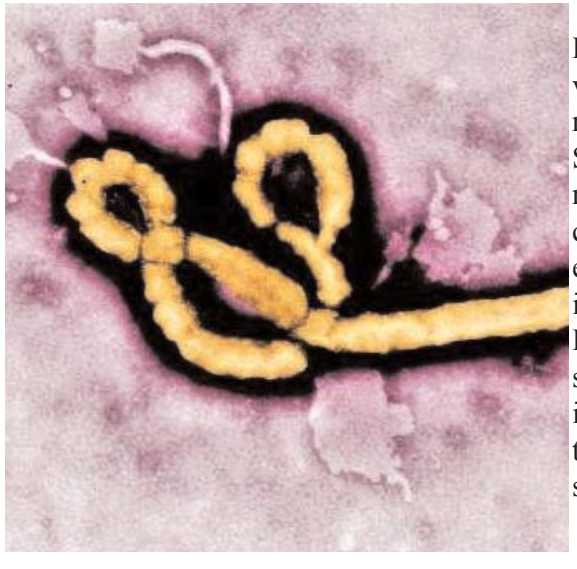
The year 1918 was very deadly, on the one hand because the fighting was still taking place in Europe and even beyond, on the other hand because a particularly virulent strain of **H1N1** influenza raged throughout the world. It would have infected one in two Earthlings, or 500 million people at the time, and would have claimed between 30 and 100 million victims, according to estimates. A true weapon of mass destruction...



The Marburg virus is designed to kill but still remains a little less deadly than its Ebola cousin. Also causing haemorrhagic fevers, this filovirus kills more than 80% of the people it infects. Its transmission from man to man is nevertheless relatively difficult since it requires very close contact between individuals, with transmission through stool, vomiting, urine or saliva.

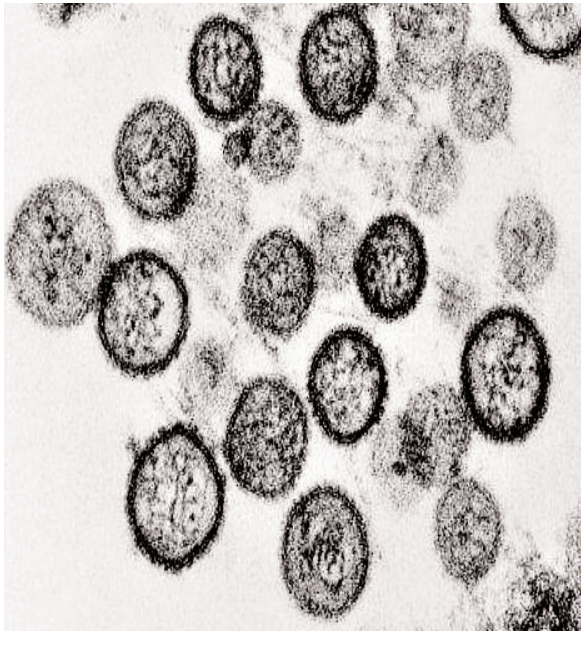


Since 1981 and the date of its discovery, **HIV** (the little green balls in the picture) has killed around 30 million people worldwide and is still spreading. This retrovirus causes AIDS (Acquired Immunodeficiency Syndrome) and ravages especially poor countries, those of the African continent in the lead. However, there are therapies that hinder the progression of the virus in the body and allow patients to live with HIV without declaring AIDS for very long years. But these are struggling to be exported outside the rich countries.



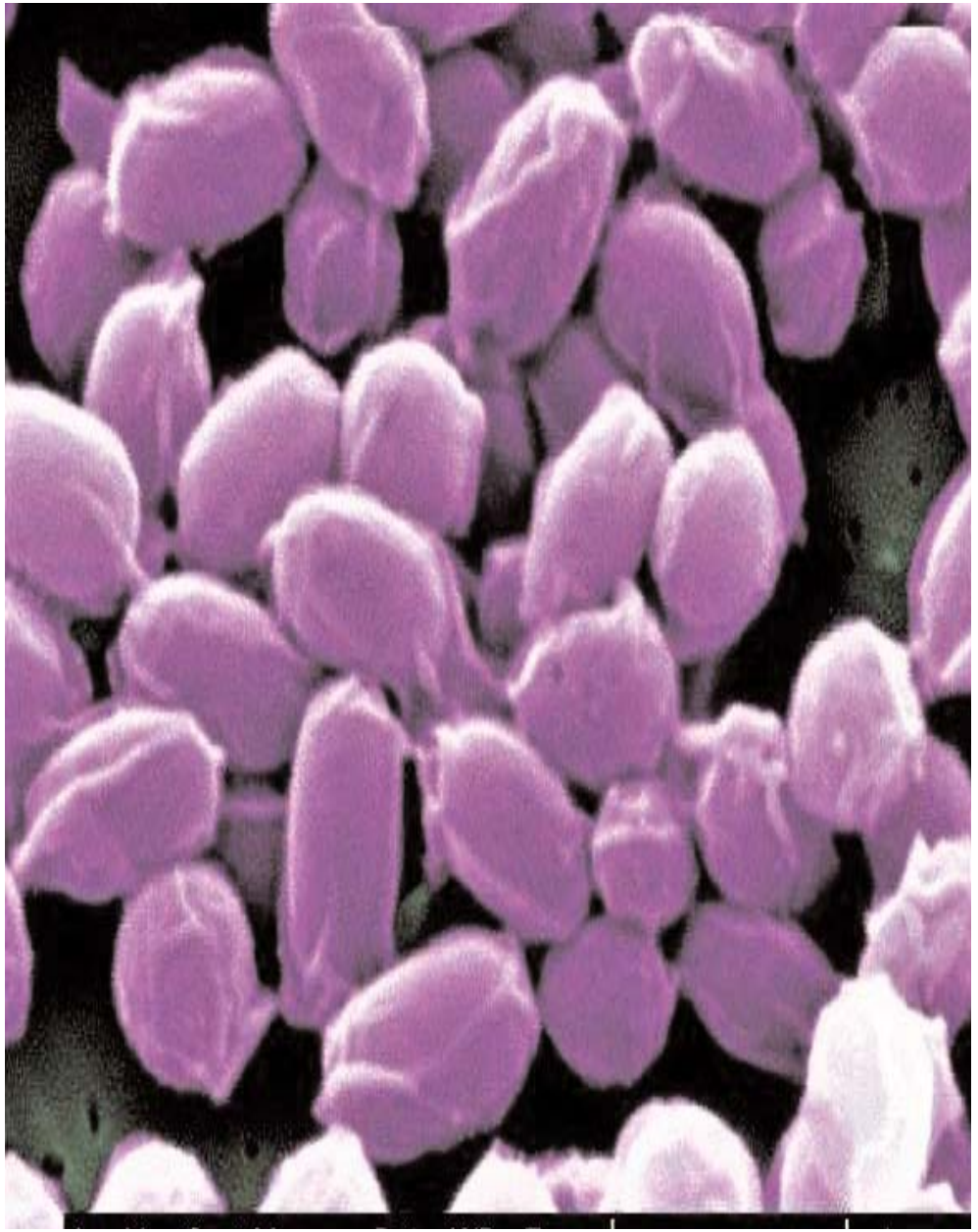
Known since 1976, the **Ebola** virus, named after a Congolese river, is one of the deadliest. Some of its strains cause hemorrhagic fevers that kill in 90% of cases. This virus has caused several epidemics in Africa, notably in Sierra Leone, Guinea and Liberia, claiming several thousand victims. Unfortunately, there is no preventive or therapeutic treatment against this terrible scourge.

It is far from being the deadliest and most pathogenic on this list, but it should not be overlooked. **The Dengue** virus, transmitted by Aedes mosquitoes, infects between 50 and 100 million people worldwide. For 500,000 people, especially children, the disease presents itself in a severe form which kills 10,000 souls. Major problem: it has been on the rise in recent decades. He who was limited to nine countries before 1970 now affects a hundred states.



Hantaviruses are a little different from the other pathogens presented in this slideshow: they prefer to attack rodents but, sometimes, in an unfortunate way, they can infect a human. In these cases, their action can be overwhelming. Causing hemorrhagic fevers or hantavirus pulmonary syndrome, they are occasionally very aggressive and commonly fatal. The Sin Number virus, or Sin Number virus (SNV), which we see in the picture, strikes rarely, but surely.

Clostridium botulinum has its own technique for committing its murders: the bacterium prefers poisoning. Indeed, it produces one of the most powerful toxins in the world, botulinum toxin. This molecule resists high heat and the acidity of the digestive system, so that when it is ingested, it enters the circulation and will block nerve communication, causing sometimes fatal paralysis.



Anthrax is caused by a bacterium called Bacillus anthracis, or anthrax. Most often, it enters the body through a wound in the skin. The body then manages to get rid of it on its own. On the other hand, when the spores of the bacteria are swallowed or breathed in, it's a whole different story. By air, it is not far from being fatal in 100% of cases. This is why it inspires bio-terrorists so much.

Plankton

Under the effect of warming, many planktonic species adapted to temperate waters migrate towards the less and less cold waters of the north, taking with them their predators, which modifies the balance of the system. In addition, the accumulation of CO2 in the ocean threatens the proper functioning of the biological pump by causing ocean acidification. This ongoing acidification could alter the rhythm of the biological engine of the ocean carbon pump.

Invertebrates, like plankton, are the source of many infectious diseases affecting humans. But not directly. They transmit pathogens to us. Perhaps, would they be able to break the chain of transmission thanks to their immune defenses? Invertebrates, such as zooplankton, transmit pathogens to humans or to animals that interact with humans. If they could fight these infections, the chain of transmission would be broken. The pathogens would be confined to invertebrates, and would not wait for a human host. Currently, they cause so-called vector-borne diseases - since invertebrates are vectors for them. All of these diseases represent some 20% of infectious diseases in the world. And cause more than 700,000 deaths a year. Malaria is responsible for more than 400,000 of these deaths.

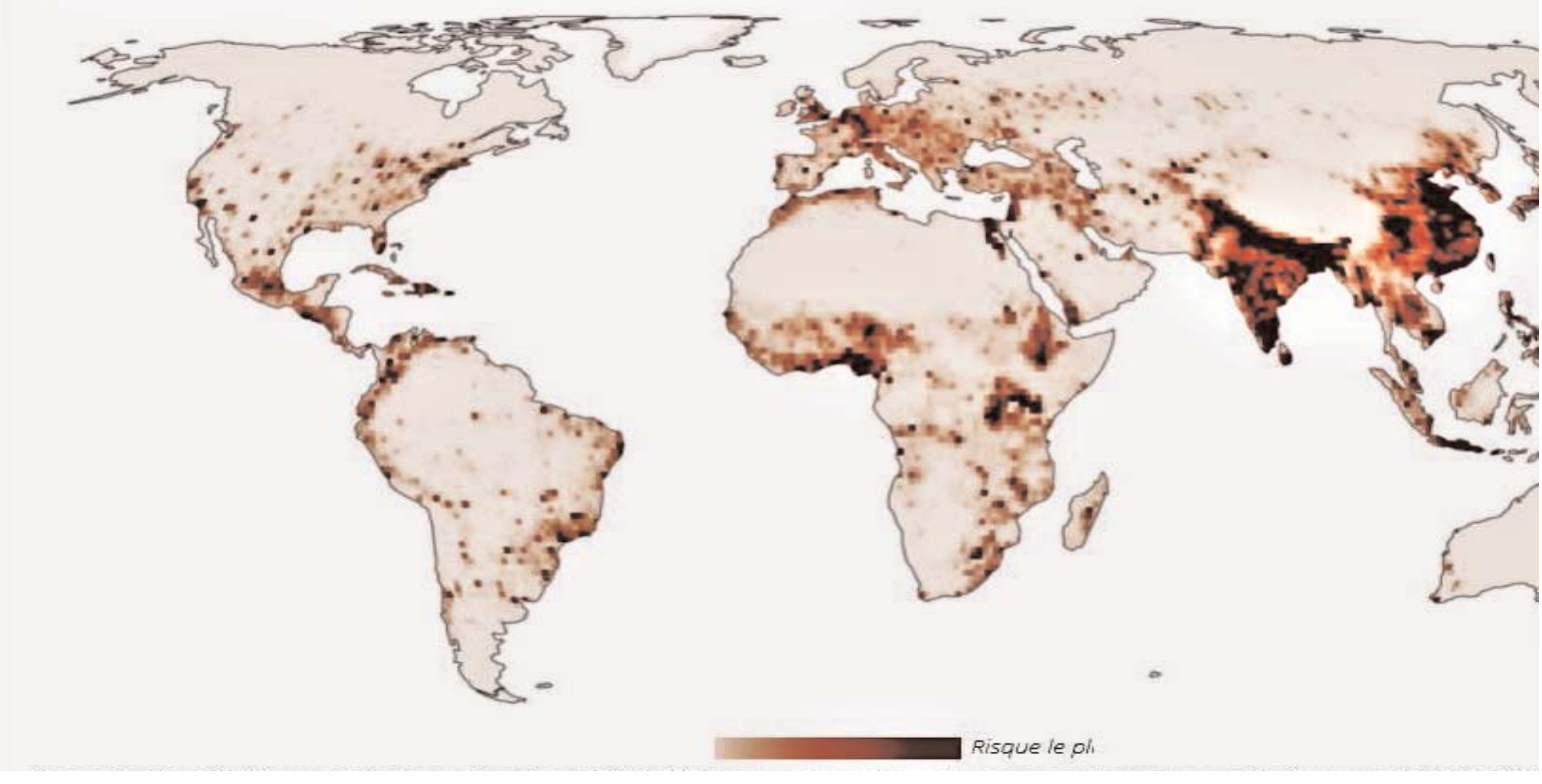
Immunity parameters

Once reached, Daphnia dentifera is doomed: the parasite develops in its body and leads to its death. After which it disperses in nature. But all these planktons would not have the same fate. Equipped with sufficient immune defences, they resist. "Our results show that there are several defenses used by vertebrates to reduce the risk of infection," explains Tara Stewart Merril, highlighting the importance of deciphering these defenses to understand infection and then prevention patterns.

Global health in a pandemic context

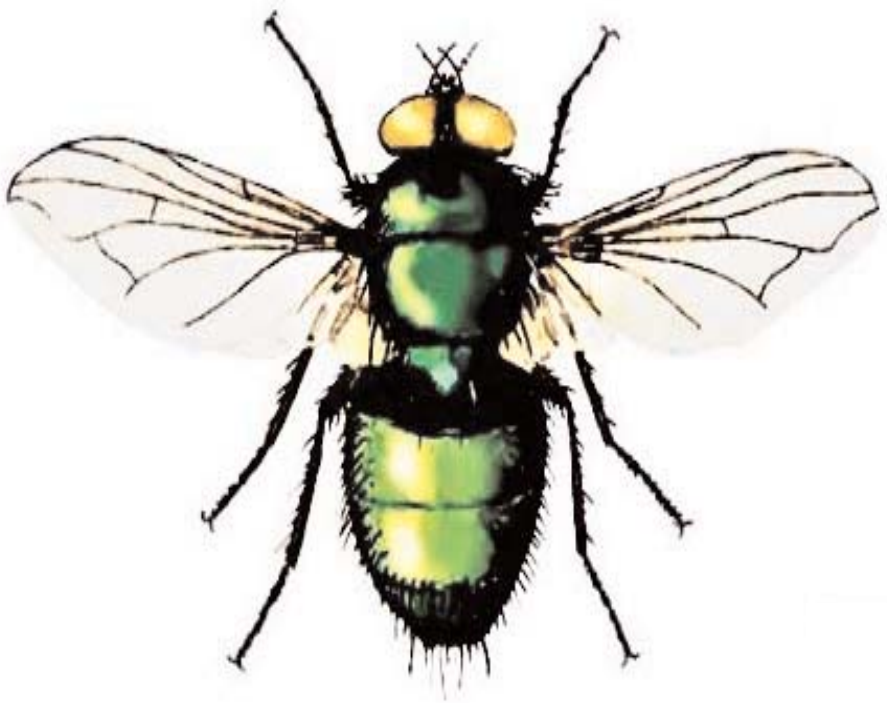
Local health risks can turn into global health threats In 2019, a new virus began to spread across the planet, causing massive impacts on human health and the global economy. By the end of October 2020, more than 46 million cases of COVID-19 had been diagnosed worldwide, but epidemiological studies suggest that this number may be underestimated. Official figures put the death toll at more than 1.2 million. This pandemic has drawn attention to zoonoses (diseases transmitted to humans from animals), to the risk of the emergence of new pathologies and to the need to properly prepare for global health emergencies.

Pathogens from wild or domestic animals - anthrax, brucellosis, rabies, Q fever, influenza type A, Rift Valley fever - cause more than 60% of infectious diseases in man. About 75% of new emerging infectious diseases, such as severe acute respiratory syndrome, Ebola hemorrhagic fever and HIV, are of animal origin. According to the researchers, the transmission of diseases from animals to humans is expected to continue and no geographical area will be spared. While tropical regions seem particularly exposed to the emergence of infectious diseases, densely populated areas are also at high risk.



THE FLY THAT KILLS

The genetic history of the fly, the only animal present in all regions of the globe for two hundred and fifty million years, is a perfect example of an animal reservoir of so-called pathogenic viruses and bacteria. There are several species of flies but the most common is the house fly (Musca domestica). These are insects that are found in the home and are distributed in many places around the world.



The housefly is usually found near food sources, it is attracted to heat and odors inside the house or outside. Musca domestica feeds on all foods. It is an insect that can feed only in the liquid state, houseflies eat by sucking. Worldwide, specialists have identified 134,000 species of flies, but the different types of Diptera are certainly more important.

Extremely serious pathogens for human health
They are transmitted by diptera, in addition to sleeping sickness: here we enter the field of tropical diseases...
Dengue fever is an extremely widespread arbovirus. It is benign but its hemorrhagic forms are formidable. Classified among the emerging diseases because of its recent geographical extension, it is frequent in travellers. The dengue viruses (four strains of Flavivirus) are transmitted to humans by mosquitoes and in particular by the female of the Aedes aegypti family, a species well adapted to urban life...

Yellow fever is an arbovirus, which takes the form of hemorrhagic fever. It is transmitted to humans by an Aedes aegypti mosquito, whose female injects the yellow fever virus into humans.

West Nile fever, also called West Nile virus disease, is a zoonosis with flu-like symptoms, very similar to dengue fever, caused by the West Nile arbovirus (group B). It is transmitted by mosquitoes of the genus Culex. This disease can be complicated by a meningeal syndrome.

Tularemia is an anthropozoonosis caused by a small aerobic bacillus, Francisella turalensis (Pasteurella tularensis), whose reservoirs are numerous (hare, rabbit, fox, rat, squirrel, wild boar, etc.). This acute infectious disease, legally deemed contagious, is transmitted either by the droppings of infected animals, by the bites of certain species of ticks, horseflies, mosquitoes or above all by contact with the remains of infected game.

Less serious naturally but still in the pathology all the same: insect bites. In our latitudes, the bites of insects such as horseflies or mosquitoes often only result in unsightly itching and swelling. These can become infected and this is often the case with the fearsome little bites of "black flies", a kind of blackfly, in Canada, in summer.

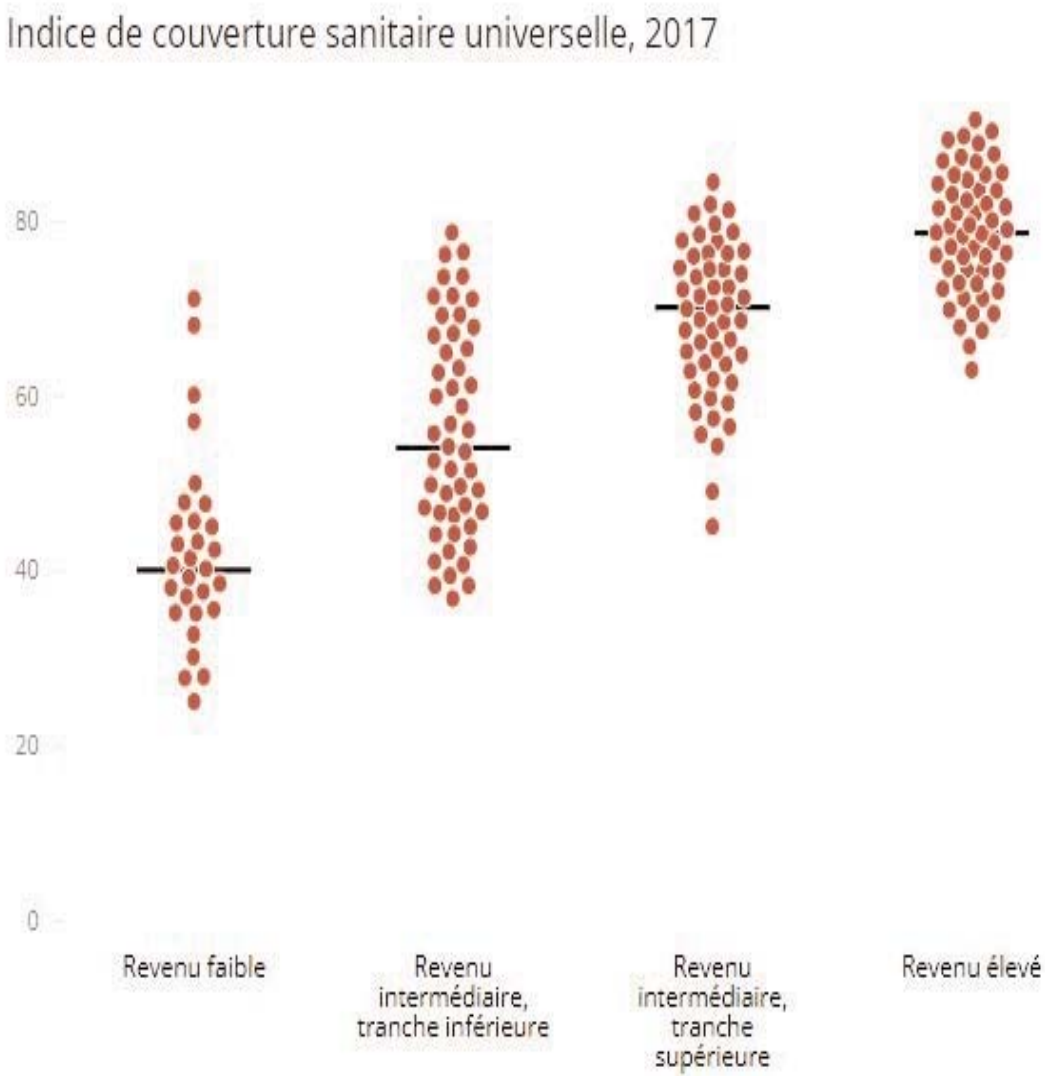
Health systems under strain

The capacities of health systems in low-income countries are often limited. The rapid spread of a new virus has put great pressure on the health systems of many countries and exposed their strengths and weaknesses, including in high-income countries. Health personnel and resource capacities vary considerably around the world, and they are often limited in the poorest countries. Thus, there are only 0.3 doctors per 1,000 inhabitants in low-income countries, ten times less than in high-income countries, which have an average of 3 doctors per 1,000 inhabitants. There are also significant disparities between poor and rich countries when it comes to health infrastructure, including hospital beds.

Providing critical care requires having a sufficient number of health workers and medical infrastructure. The COVID-19 pandemic has shown that even countries with well-developed health systems can struggle with rapidly rising numbers of people requiring treatment and hospitalization. Access to health care and financial risk vary by income level. To benefit from critical medical care, the place where one lives can be decisive. Data on universal health coverage (UHC) highlights two interrelated aspects: the rate of coverage of health services (SDG target 3.8.1) and financial risk protection (target 3.8.2). The service coverage index measures the extent to which people in different countries have access to essential health services, and takes into account reproductive, maternal, neonatal and child health, the treatment of infectious diseases and non-communicable diseases, as well as as the capacity of the health system and its accessibility.

Service coverage tends to improve with income, but there are large differences between countries and regions. However, even when medical services are available, people sometimes have to incur significant expenses to use them and often forego treatment due to high

Universal Health Coverage Index (2017)

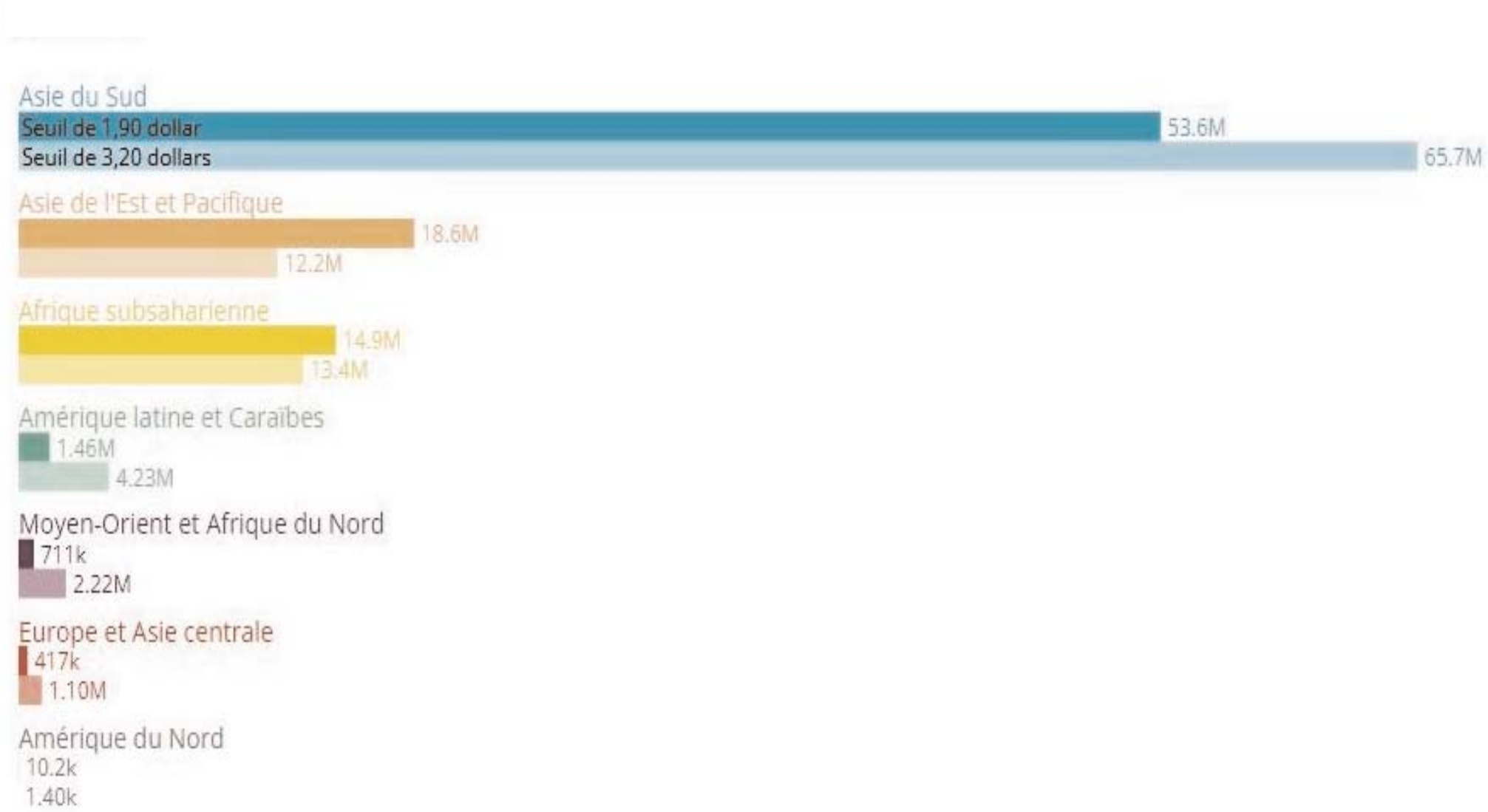


costs. The CSU target also helps determine whether patients can receive the care they need without suffering financial hardship and incurring catastrophic expenditure (defined as 10% or more of total consumption or income). The most recent estimates, for 2015, indicate that 90 million people have fallen into extreme poverty (below the international threshold of $1.90 a day) because of healthcare costs. Most of these people lived in South Asia (54 million), followed by East Asia and sub-Saharan Africa. In addition, 99 million

people in the world have fallen below the international poverty line (less than 3.20 dollars a day) under the weight of health expenditure.

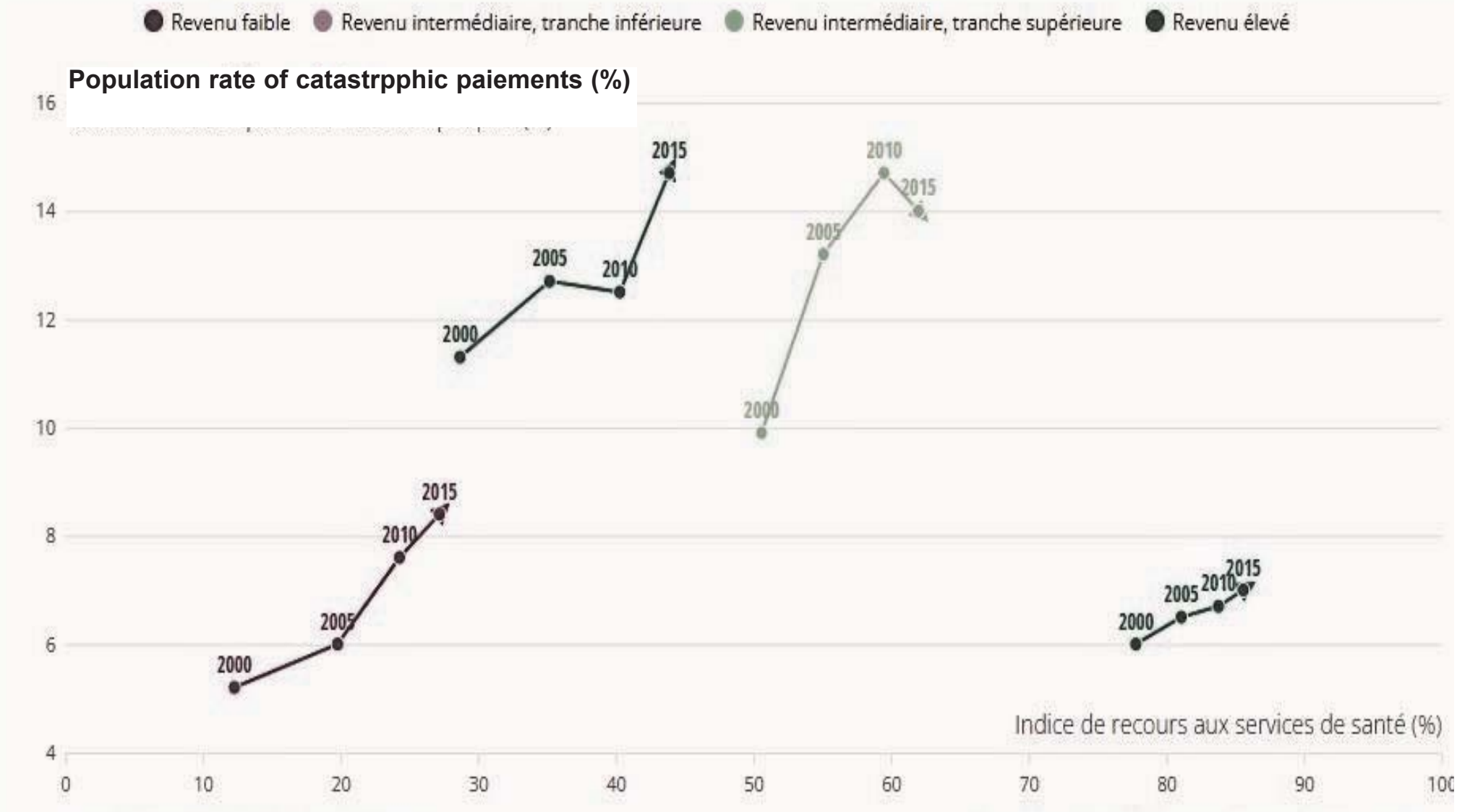
When countries move from low income to higher income, the burden of out-of-pocket spending to finance growing health demand initially increases. This often translates into higher financial risk for people in middle-income countries. Indicators on financial protection should be interpreted alongside those on service coverage. If only a small part of the population faces catastrophic health expenditure, it may mean that the financial barriers to accessing care are so high that many people forego treatment, a phenomenon characteristic of low-income countries. where service coverage is poor. However, this may reflect a situation where service coverage is high and social safety nets promote affordable care (a situation typical of high-income countries).Out-of-pocket payments are one of the most important sources of health financing, especially in

Tens of millions of people are pushed into extreme poverty due to their health expenses



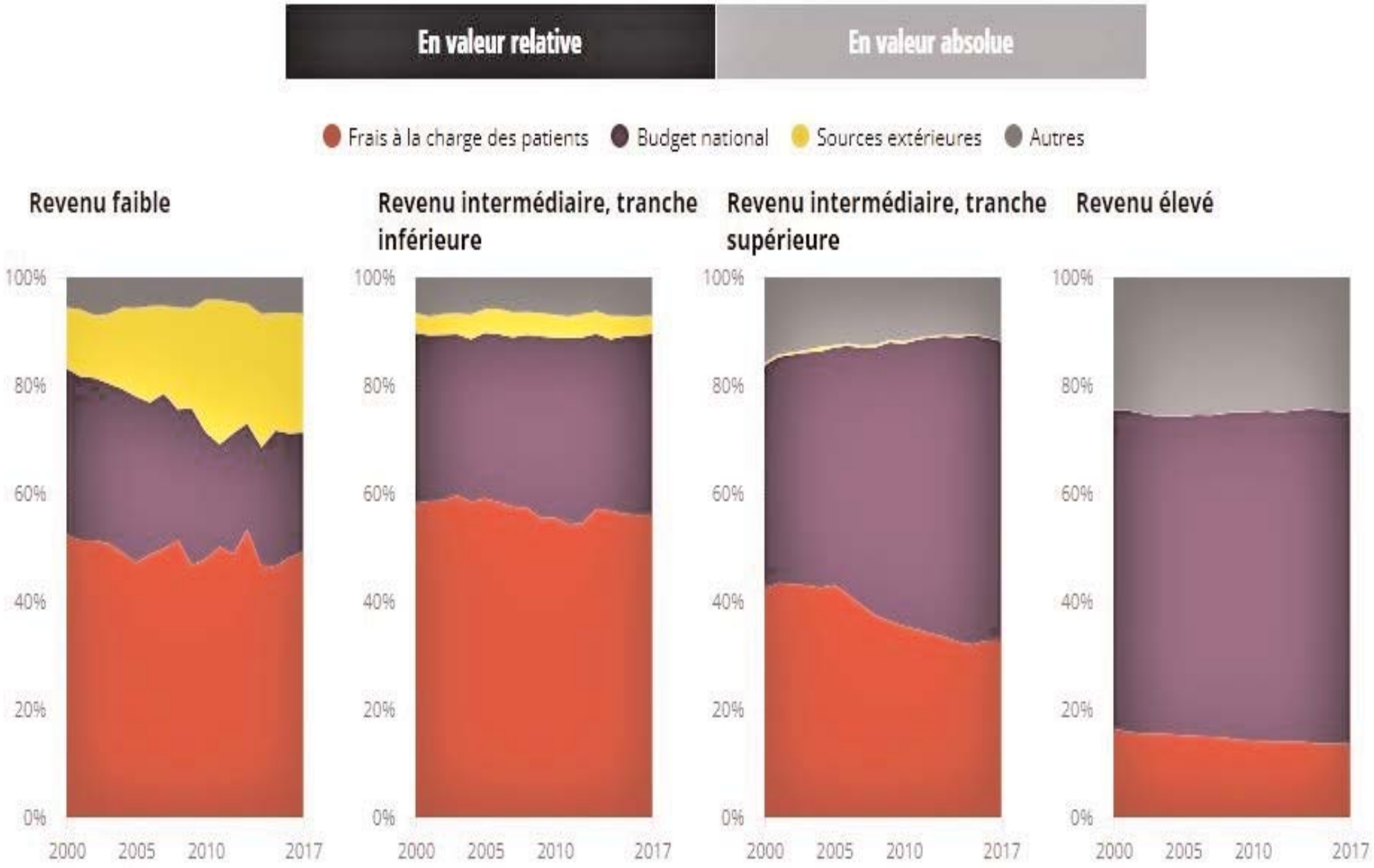
low- and lower-middle-income countries, where they account for at least half of total health care financing . Low-income countries also rely heavily on external sources of financing. When these countries move towards middle income, external financing tends to decrease significantly and is not, in most cases, immediately compensated by an increase in domestic public resources.

Therefore, individuals must pay more out of pocket to fill the gap, until public resources increase enough to support health financing and reduce the relative need for out-of-pocket expenditure. .In absolute terms, the gap between rich and poor countries in health spending per capita is colossal: in 2017, high-income countries spent more than 60 times more per capita on health than low-income countries. lower-middle income, and 120 times more than low-income economies.



Source : Institute for Health Metrics and Evaluation, Organisation mondiale de la santé et Banque mondiale. 2019. Global Monitoring Report on Financial Protection in Health 2019.

Source of health financing by income group



Source : Organisation mondiale de la santé et Banque mondiale. 2019. Global Monitoring Report on Financial Protection in Health 2019

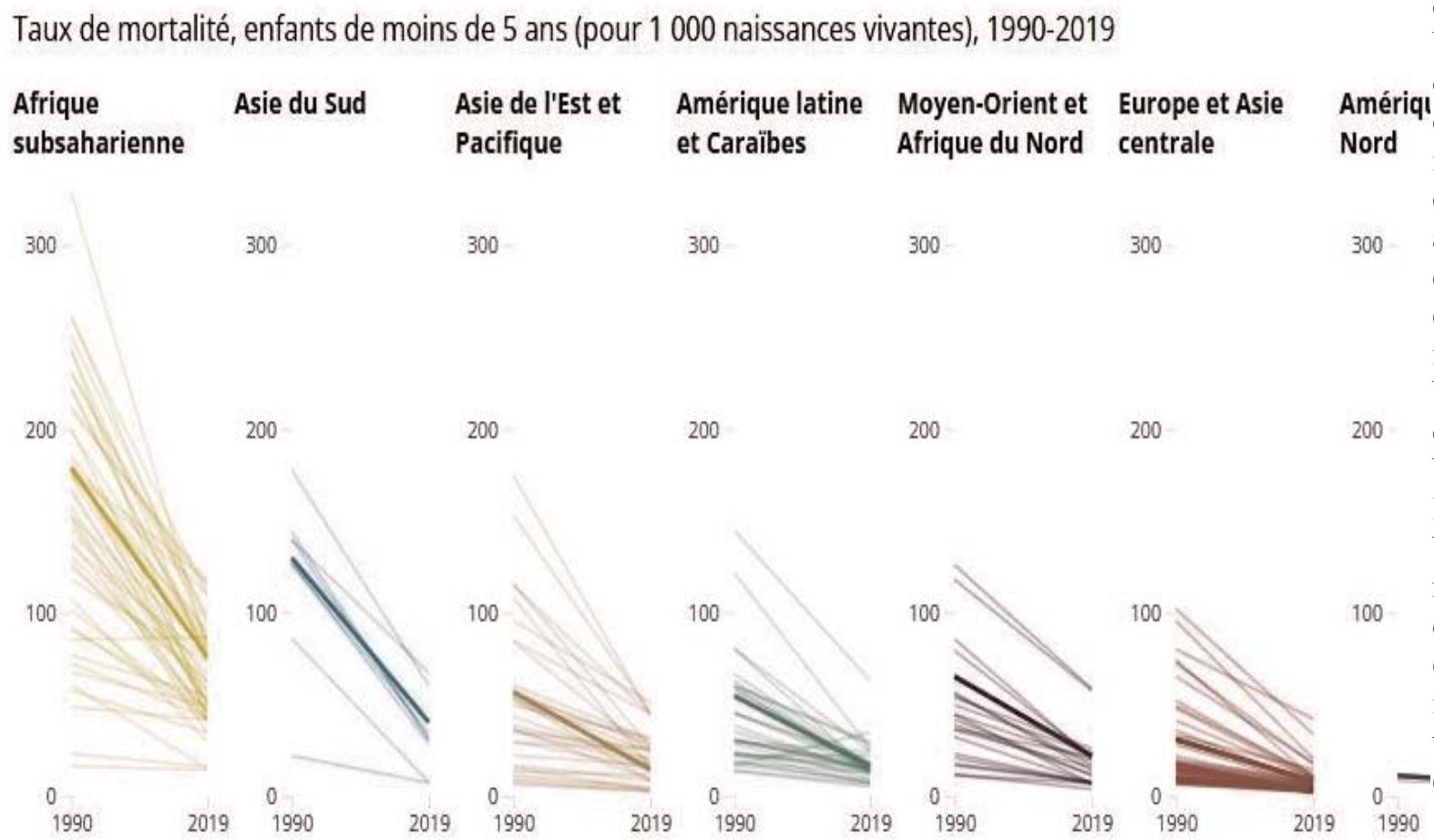
Performances sanitaires mondiales et impact potentiel de la COVID-19

The COVID-19 pandemic is not over. Pressures on health system resources and delays caused by logistical difficulties are expected to lead to substantial setbacks in key SDG health indicators, including infant and maternal mortality rates, immunization rates, incidence of tuberculosis and HIV prevalence.

Under the SDGs, it is imperative to end preventable deaths of young children (SDG target 3.2). Over the past 30 years, the global infant and child mortality rate (the probability that one in 1,000 newborns will die before reaching the age of five) has fallen by around 60%. Although all regions have made progress, vast geographical disparities remain. In 2019, two regions alone accounted for 80% of deaths of children under five: sub-Saharan Africa with the highest infant and child mortality rate in the world (76 deaths per 1,000 live births), followed by by South Asia (40 deaths). One in 13 children in sub-Saharan Africa and one in 25 in South Asia die before their fifth birthday.

Considerable efforts will be needed in 73 countries (including 40 in sub-Saharan Africa) to achieve SDG target 3.2 of reducing under-five child mortality to no more than 25 deaths per 1,000 live births by 2030. half of the deaths of children under the age of five occur soon after birth, many infant and maternal deaths could be prevented by better access to quality prenatal care, skilled personnel during childbirth and postnatal care for mothers and their babies.While the number of child deaths directly attributable to COVID-19 remains low compared to those caused by other common illnesses, many children are at high risk of dying due to the indirect effects of the pandemic, including widespread disruptions in the supply and use of essential health services.

Deaths of children under five concentrated in sub-Saharan Africa and South Asia



It is therefore possible that people postpone or forgo their visits to health centers for childbirth, treatment, vaccination and follow-up examinations for fear of contracting or spreading COVID-19. Indirect effects also include an increase in malnutrition due to the disruption of food supply chains as well as a decrease in the accessibility of nutritious foods due to decline in household income. These difficulties can lead to child malnutrition and low birth weight, two major factors in infant mortality. The number of additional deaths each month is estimated between 42,000 and over 190,000, depending on the severity of the impact of the lockdown. More newborns could die during the pandemic as fewer women breastfeed for fear of transmitting COVID-19. However, declining breastfeeding rates make newborn babies more vulnerable to illnesses such as pneumonia and diarrhoea.

Estimated number of maternal and child deaths based on Covid 19 scenarios

Nombre de décès supplémentaires en rouge

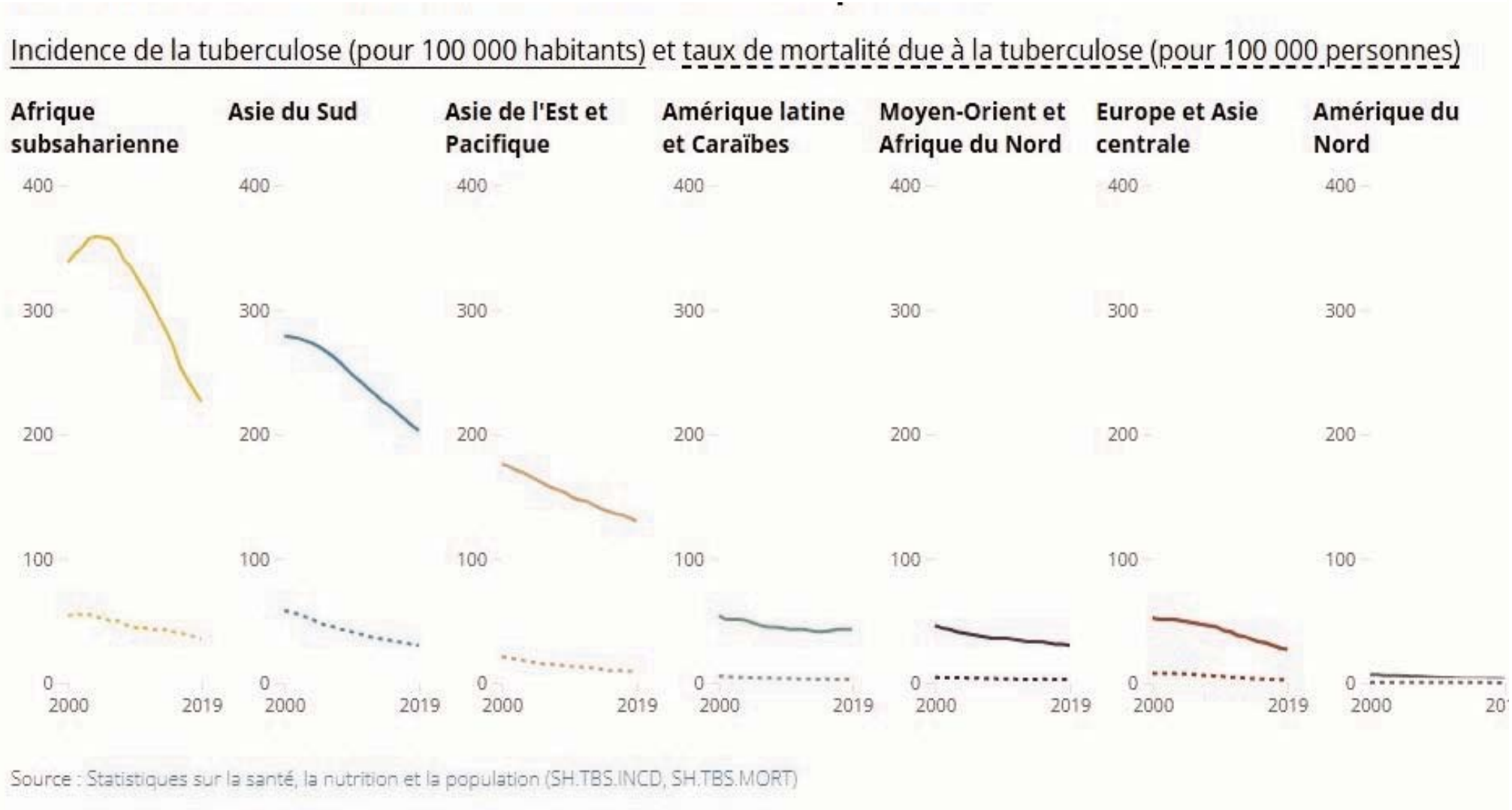
Scénario	Décès infantiles	Décès maternels
Référence	431,690	24,500
Scénario 1 : Réductions limitées de la disponibilité du personnel et des ressources sanitaires en raison de la réaffectation des ressources pour répondre à la pandémie	473,930 +42,240	26,530 +2,030
Scénario 2 : Perturbations plus importantes des systèmes de santé en raison de problèmes de personnel et d'approvisionnement	506,220 +74,530	28,100 +3,600
Scénario 3 : Perturbations du système de santé et restrictions strictes de déplacement, imposant aux familles et aux travailleurs non essentiels de rester à la maison	624,520 +192,830	33,950 +9,450

Note : Les chiffres des décès supplémentaires chez les enfants prennent en compte les effets de l'aggravation de la dénutrition.

Global TB incidence has fallen by almost a quarter since 2000 (SDG target 3.3). In 2018, the highest incidence was recorded in sub-Saharan Africa (230 new and relapsed TB cases per 100,000 people) and South Asia (206 cases). Tuberculosis mortality also remains significantly higher in sub-Saharan Africa than in the rest of the world. The higher incidence of HIV in the region is an aggravating factor, as a weakened immune system makes it more likely for people with latent TB infection to develop the disease.

Between 2000 and 2018, approximately 58 million lives were saved through the diagnosis and appropriate treatment of tuberculosis. However, the COVID-19 pandemic is likely to have very negative consequences on access to these services and their availability. According to a study carried out in the spring of 2020, even a short-term confinement limiting the possibilities of diagnosis and treatment could increase the number of undetected tuberculosis cases by almost two million and the number of deaths by more than 300,000 during the last few years.

Global TB incidence down 25% since 2000


Incidence de la tuberculose (pour 100 000 habitants) et taux de mortalité due à la tuberculose (pour 100 000 personnes)
Afrique subsaharienne
Asie du Sud
Asie de l'Est et Pacifique
Amérique latine et Caraïbes
Moyen-Orient et Afrique du Nord
Europe et Asie centrale
Amérique du Nord
400
300
200
100
0
2000
2019
Source : Statistiques sur la santé, la nutrition et la population (SH.TBS.INCD, SH.TBS.MORT)

A recent meta-analysis estimated that 6.3 million additional people will develop TB between 2020 and 2025 due to disruptions in TB services related to the COVID-19 pandemic, and that 1.4 million more people will fall victim to it. Achieving an optimal vaccination rate often takes a long time.

The COVID-19 pandemic has highlighted the need to find rapid and effective ways to organize and implement vaccination campaigns around the world, starting with the most vulnerable populations. Previous and current vaccination programs show that complete eradication of a disease can be very difficult.

The SDGs (development goals) promote research and development of vaccines and medicines for communicable and non-communicable diseases that mainly affect developing countries (SDG target 3.b).

Estimated increase in TB cases and deaths between 2020 -25 based on Covid 19 scenarios

Nombre de cas et de décès supplémentaires en rouge

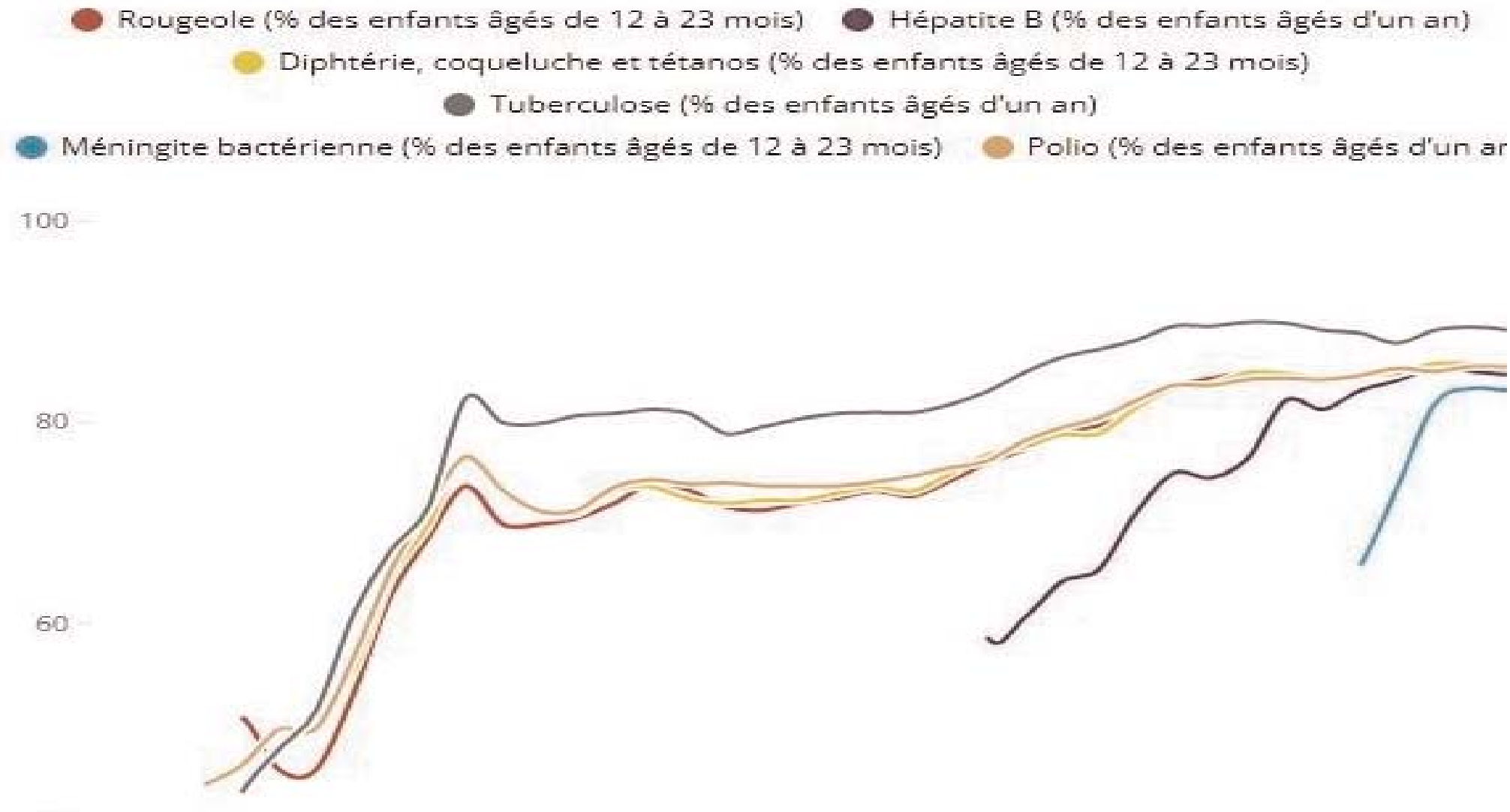
Scénario	Cas de tuberculose	Décès dus à la tuberculose
Référence	59,000,000	8,550,000
2 mois de confinement + 2 mois de relèvement	60,826,400 +1,826,400	8,892,500 +342,500
3 mois de confinement + 10 mois de relèvement	65,331,100 +6,331,100	9,917,300 +1,367,300

Source : The Potential Impact of The COVID-19 Response on Tuberculosis in High-Burden Countries: A Modelling Analysis. Mai 2020. Réalisée par Stop TB Partnership, en collaboration avec l'Imperial College, Avenir Health, l'université Johns Hopkins University et l'USAID.

Today, global childhood immunization rates against diseases such as measles, diphtheria, pertussis and tetanus, polio and hepatitis B are as high as 80-90%. Often, it has taken decades to achieve these results and large differences remain between countries.

A measles vaccine has been around since 1963. The World Health Organization recommends reaching a vaccination rate of more than 95% to achieve sufficient immunity in the population to prevent the spread of measles (herd immunity) . However, of the 192 countries with data in 2019, only 82 met this threshold and, in 13 countries, the rate was below 60%. In 2018, more than 140,000 people world-wide died from measles. The diphtheria, pertussis and tetanus (DCT) vaccine has been available since 1948. About one-third of countries with data (65 out of 194) have vaccination rates below 90%. About 60% of unvaccinated children live in ten countries: Angola, Brazil, Democratic Republic of Congo, Ethiopia, India,

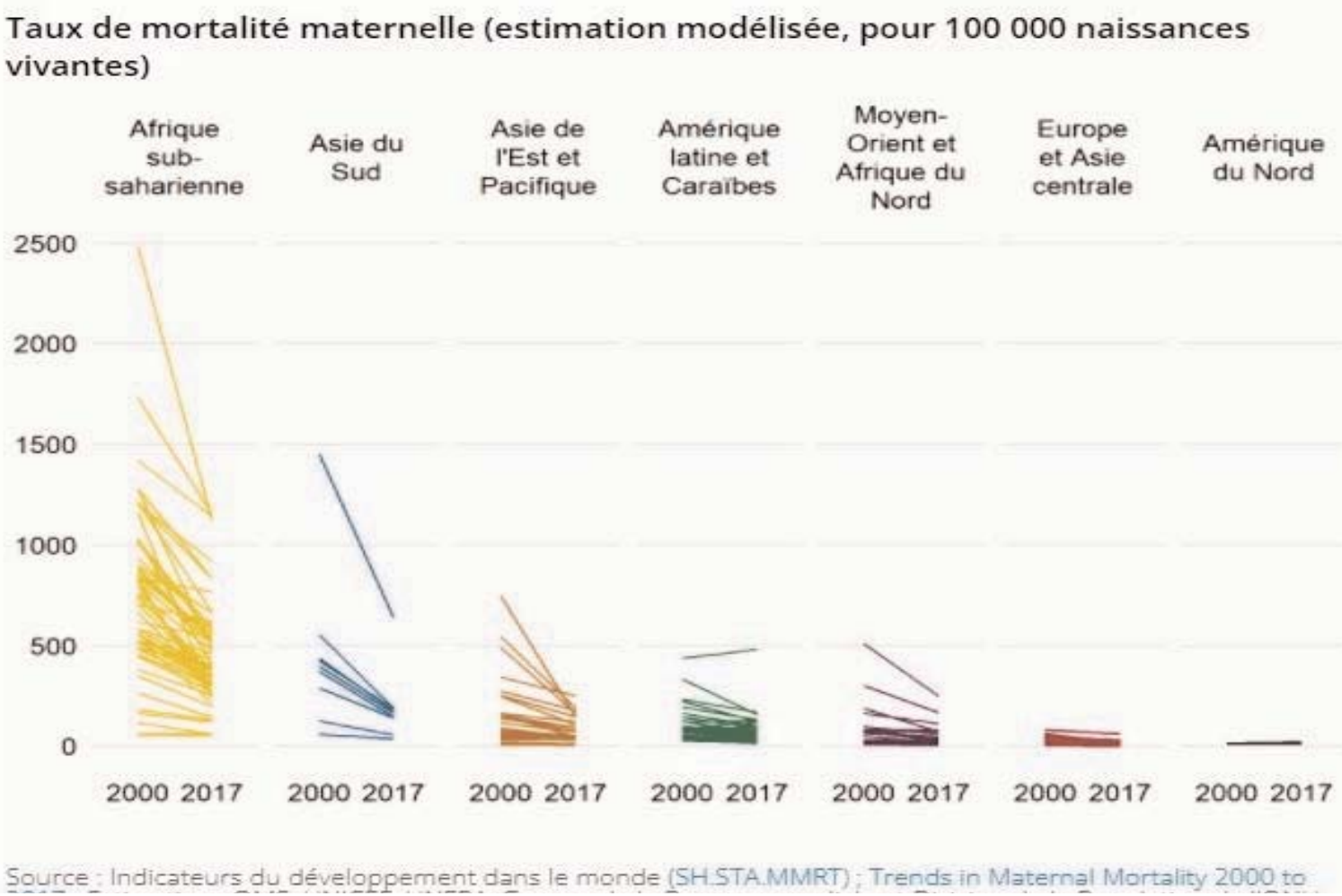
Global immunization rates


Rougeole (% des enfants âgés de 12 à 23 mois)
Hépatite B (% des enfants âgés d'un an)
Diphtérie, coqueluche et tétanos (% des enfants âgés de 12 à 23 mois)
Tuberculose (% des enfants âgés d'un an)
Méningite bactérienne (% des enfants âgés de 12 à 23 mois)
Polio (% des enfants âgés d'un ar
100
80
60

Indonesia, Nigeria, Pakistan, Philippines and Viet Nam. Even in countries where they are considered eradicated, reduced vaccination rates could cause considerable spikes in the reappearance of these diseases.In addition to the challenges of developing and delivering COVID-19 vaccines globally, containment measures threaten to drastically drop childhood vaccination rates against many infectious diseases, including measles and polio. While the barriers to maintaining vaccination campaigns are significant in low-income countries, there are also marked declines in vaccination rates in high-income countries.

Maternal mortality has fallen by almost 40% since the year 2000

Le taux de mortalité maternelle dans le monde est passé de 342 décès pour 100 000 naissances vivantes en 2000 à 211 décès en 2017. Cependant, les dernières tendances indiquent que ce taux devrait s'élever à 189 décès en 2023, soit un résultat insuffisant pour atteindre la cible 3.1 des ODD, à savoir moins de 70 décès pour 100 000 naissances vivantes en 2030.



Source : Indicateurs du développement dans le monde (SH.STA.MMRT) ; Trends in Maternal Mortality 2000 to

Diseases and food: overconsumption of food

The increase in the frequency of many diseases is caused by harmful variations in environmental factors. Food is the first environmental variable. Industrialized food, which has made it possible to feed the West in sufficient quantity, has pushed its inhabitants to "overconsumption" and to turn a blind eye to the quality of what they eat.

The new "epidemics"

"Epidemiology" is the historical study of infectious disease epidemics and their development across human populations worldwide.This term has changed its meaning slightly. Today, this science has evolved into the study of disease frequencies and variation in a given human population. Thus we can speak of an "epidemic of obesity", or an "epidemic of osteoporosis" which has reached the West. The increasing rates of diabetes, cardiovascular diseases and cancers worry epidemiologists, and rightly so.

We dare not officially speak of an "epidemic" with regard to these diseases, but this idea is in all the heads of researchers, as with Alzheimer's disease.

Food: first environmental variable

The increase in the frequency of many diseases is caused by harmful variations in environmental factors. Industrialized food, which has made it possible to feed the West in sufficient quantity, has pushed its inhabitants to "overconsumption" of food, by making them forget the quality of what they eat.

Result: we eat too much and we do not eat in an appropriate way. And the consequences are felt physically.

For 200,000 years, nature has given us quality food molecules. The evolution of Man brings cooking and food processing. If this represents an improvement in daily life, the consequences on the body are more negative.

Our 25,000 human genes were forged over 200,000 Paleolithic years, when we were "gatherer-hunters" adapted to nature's nutrients.

Neolithic food revolutions

Nowadays, it is no longer freedom that guides the enslaved people... it is "junk food" that directs manipulated consumers towards obesity, diabetes and rheumatism: osteoarthritis, osteoporosis, arthritis!

Around 10,000 years ago, in the Neolithic period, three food revolutions changed the way people survived.

The three food revolutions of the Neolithic

These three revolutions led to:

1) the selection of cereals (example of "mutated" wheat, which has become a "genetic monster" having tripled the number of its chromosomes, obviously coding for indigestible proteins: the too famous "gluten");

2) immoderate consumption of animal milk (eg lactose, when only 15% of the world's population can digest milk sugar after the seventh year);

3) the overcooking at high temperature of the fragile molecules produced by nature (example of vitamins destroyed by cooking).

The hunter-gatherer becomes a "farmer" and settles in the first villages. A few centuries later, Homo sapiens sapiens tamed the animal, became a "breeder" and consumed animal milk for the first time. Finally, he cooks his food by overheating it.

In addition, the chemical errors of the 20th century produced thousands of molecules unknown to the planet: insecticides, solvents, herbicides, all geared towards the idea of killing... bad plants, pests, insects, bad microbes and other viruses that exist on Earth... (and existed there long before us); or dyes, invented with the absurd idea of coloring our food, to make it more attractive or to try to conceal all the industrial processes of preservation or "purification" which denature it.

Having pierced the mysteries of the genetic code, scientists invented GMOs: genetically modified organisms. Their goal is to improve nature: to invent the plant that grows, without water, to feed humanity by cultivating the deserts. Their mercantile dreams ignore the attempts that nature has already made over millions of years of evolution to arrive at the perfection of all forms of life forming biodiversity.

"Insecticidal" plants have thus been invented to increase production yield by a few percentages, traditionally left to predators, which are also part of biodiversity. By not taking into account the rules of the interdependence of all that lives on the planet, this risks costing dearly to the one who is at the end of all the food chains: Man.

It is not a question of wanting to return to the age of the caves because Humanity has progressed in morals and civilization has made upheavals to free itself from the grip of nature.

There are simply limits of "domestication" of nature that should not be crossed; wanting to twist it, enslave it, deform it, exploit it, imprison it, or poison it... is to ignore that we are entirely part of it. We need to choose our food carefully.

Men's adaptation to their new diet
Man denatures his food, making himself master of nature. The speed at which our genes and digestive enzymes adapt to process these new food molecules is not sufficient to be able to assimilate these new nutrients without hassle.

The human species will no doubt adapt to the "modern diet" but natural selection is harsh on the individual who pays a high price through disease. Darwinian evolution is thus made, there is indeed an adaptation to the environment, by the creation of new species better adapted (speciation), but the time scale of this adaptation is not of the same order of greatness, than the fleeting life of a human being.

The disease is the sad meeting of Paleolithic genes (these are ours!) and a "modern diet".

It is for the moment difficult to change our genes... On the other hand, it is of the order of possible, by our human freedom, to change food. This requires awareness and then a permanent effort in the hostility "of the environment", ignoring the laws of "genomics" and the principles of Darwinian evolution.
Food is like engine fuel. Food molecules are slowly produced by nature. Plants and animals manufacture carbohydrates, lipids, proteins, which we do not all know how to manufacture.

Food sorcerer's apprentices.

If we add to these natural elements chemical structures invented by our claim to do better than millions of years of evolution (aspartame, etc.), or our presumption to help the digestive function by "cooking the molecules" at high temperature ; if we add dyes to "make it prettier" on our plate... We are playing sorcerer's apprentices... We are not surprised to fall ill!

A worldwide syndrome

Obesity, malnutrition and climate change are three facets of the same threat to humanity: a "global syndemic" that must be combated globally. The disappearance of wildlife, global warming, obesity and malnutrition... everything is interconnected. One cannot speak of one without taking into consideration the other problems.

The common drivers of these three evils are powerful commercial interests, an insufficient and inadequate political response, and a lack of civil society mobilization that is too focused on immediate economic growth. A preliminary observation: it is estimated that by 2050, the global demand for food and animal feed will increase by 50 and 70% respectively.

Another finding: the number of obese people has more than doubled in 73 countries since 1980 and continues to grow in other nations, leading to a sharp increase in diseases related to overweight. Excess body weight affects 2 billion people worldwide, causing 4 million deaths, at an annual cost of 2 billion US dollars, or 2.8% of global GDP.

Deforestation, species loss, pollution and climate change are progressing concurrently. The consequences will be particularly dramatic for the poorest countries and for the most deprived populations.

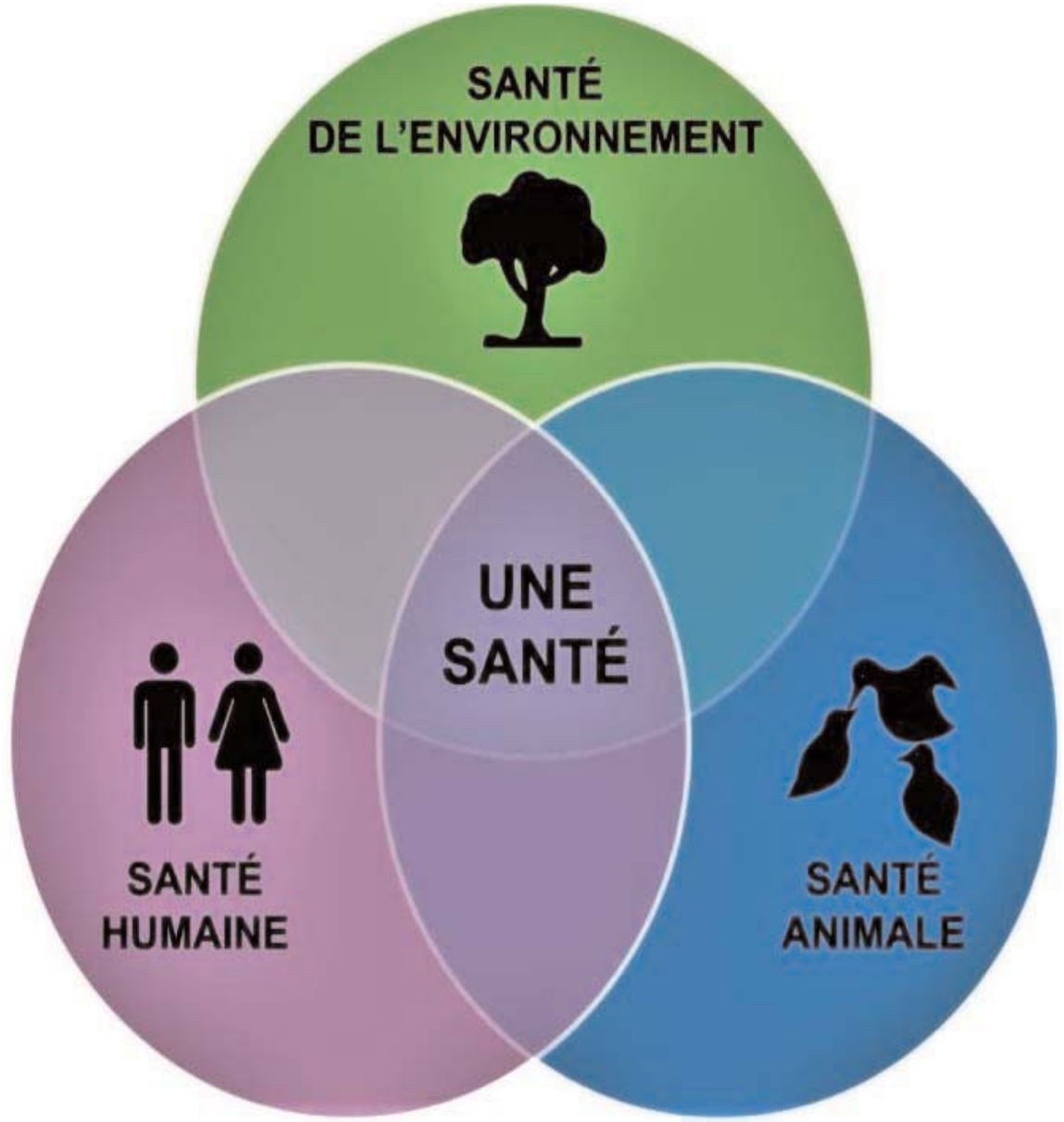
Extreme weather events could both deprive some populations of food and drive up the price of fruits and vegetables. This will increase the consumption of ultra-processed industrial foods with the consequent increase in greenhouse gas emissions. This will destabilize the natural balance of the Planet by contributing greatly to global warming.

What society do we want for ourselves and our descendants?

What are the consequences of global warming for food?

Climate instability is a major factor in increasing hunger in the world and is one of the main causes of serious food crises according to the Food and Agriculture Organization of the United Nations (FAO) .

The food vulnerability levels of populations are increasing significantly. Today more than 690 million people in the world suffer from hunger for various reasons and climate change is one of them. If left unchecked, an additional 600 million people could go hungry by 2080 due to climate change. 183 million people are food stressed because they suffer from severe food insecurity.



The tension on the water becomes untenable. With increasing droughts, farmers are demanding more water reservoirs, even if it means building them illegally. Our current diet puts additional pressure on groundwater and waterways. Solutions must be found that combine beneficial effects for biodiversity and mitigation of climate change. The agri-food giants are in the process of appropriating groundwater, which will increase international political tensions in this area in the coming decades, contributing to further weakening precarious populations.

What are the nutritional means of combating global warming?
However surprising it may seem, fighting obesity is a way to fight global warming. According to the authors of a study published in the Journal Obesity in 2019, the increase in the average weight of human beings (650 million people are obese, according to the UN) and the increase in population (we will be nearly 10 billion in 2050) cause a sharp increase in greenhouse gases.

Changing eating habits may be more complex than it seems. The respective pro-

portions of animal and vegetable proteins in the diet of the French are around 60/40, whereas the recommendations of the World Health Organization (WHO) are 50/50. Even if it is obvious that we must reduce our share of animal proteins that are too polluting and harmful to our health when they are consumed in excess, the switch to vegetable proteins is not necessarily more virtuous at the ecological level if we take the example of Amazonian deforestation in order to free up spaces for the production of soybean meal.

In any case, you have to eat locally and do as much as possible the hunt for air transport of foodstuffs that can be found near your home.
A worrying sign for the future of Humanity is that we are witnessing a constant increase in meat consumption in the world. Because all the populations of emerging countries signify their change of social rank by starting to consume what they could not be offered previously: meat foods and increasingly processed or ultra-processed foods.

How does weight affect the production of greenhouse gases?
The metabolism of obese people produces more CO2: 81 kg of CO2 more each year, overconsumption of food and drink and modes of transport respectively 593 kg and 476 kg of additional CO2 per year.

People with obesity need more food to sustain themselves, without forgetting that their transport requires more energy and therefore an increased consumption of fossil fuels. Treating obesity can, in addition, bring beneficial effects on morbidity, mortality and health care costs, have a positive effect on the environment

What avenues to suggest?
While there are opportunities to change the food paradigm, it seemed edifying to me that, during the successive confinements, no television campaign mentioned prevention by fighting against the sedentary lifestyle and weight gain of our fellow citizens. We could have offered alternatives to prepared meals, by asking consumers to eat locally, to prepare inexpensive and balanced meals in protein, by promoting, for example, vegetable proteins that are less expensive than animal proteins to populations in a precarious economic situation. such as students, the unemployed, migrants newly settled in France, the elderly...

It was a unique opportunity to promote a new mode of consumption, but the Ministry of Health or an organization like Public Health France only focused on Covid-19 by generating a particularly anxiety-provoking climate and therefore a source of food cracking. The proof, the French took on average 2.5 kilos during the first confinement.

A combination of public health policies (promotion of healthy diets and physical activity) and fiscal and fiscal policies (funding of sustainable production methods, taxes to reduce the consumption of red meat or promote non-motorized transport, etc.).
We must adapt our diet according to the seasons and eat locally as much as possible.

Our crops need to be more adapted to the seasons and our soils. It is also necessary to let the land rest by leaving it fallow. We are depleting our soils and our water.
Proteins of animal origin are present in meats, fish and seafood, eggs and dairy products. They provide, in balanced proportions, all the essential amino acids the body needs. Consumers must be educated to vary their sources of animal protein but not to sacrifice them out of ignorance of equivalences. People wishing to change their dietary pattern (vegetarianism, veganism) must be accompanied and in any case educated.

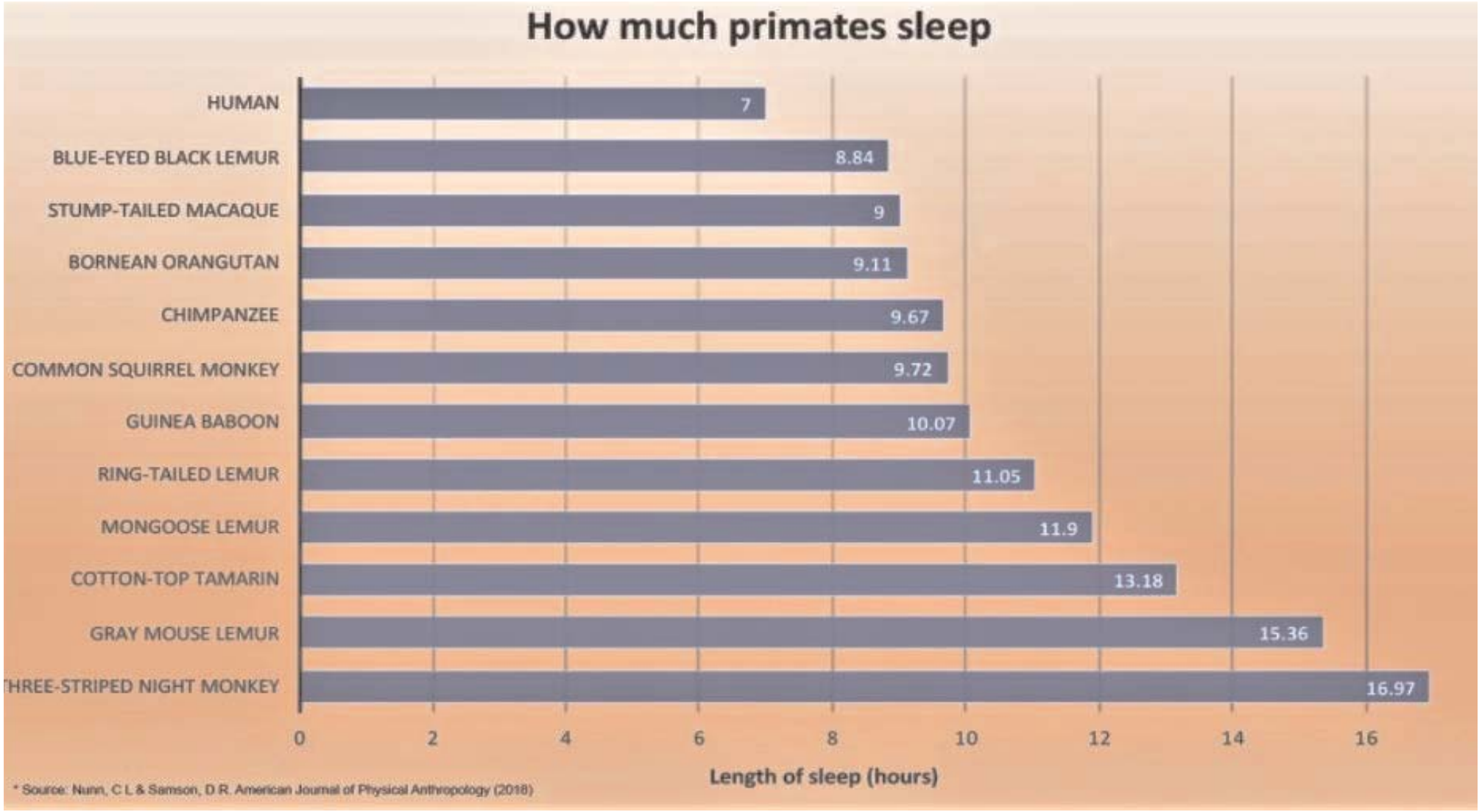
Plant-based proteins from cereals (wheat, rice, corn, barley, rye, etc.) and products made from them (flour, bread, pasta, etc.), tubers (potatoes), vegetables beans or legumes (split peas, chickpeas, lentils, broad beans, white beans, red beans, etc.) are unbalanced in one or more essential amino acids. However, by judiciously combin-

ing foods, either of animal and plant origin (eg pasta with Gruyère), or cereals and legumes (eg rice and red beans, semolina and chick-peas, etc.), it is possible to constitute an intake of vegetable proteins of acceptable and inexpensive nutritional quality. Posters or campaigns promoting vegetable proteins would be welcome.

Other sources of inexpensive and perfectly legitimate proteins can be improved at the level of the exploitation sectors, I am thinking of seaweed, France having one of the largest maritime areas in the world.

Food education must begin from the moment of conception of the child with pregnant women by evoking this differently according to social background, origin, economic means, place of residence. We do not talk about nutrition to 67 million French people equally. The speech must adapt.

It is essential to carry out this education as early as possible in a transversal way by including all sorts of players in civil life, whether doctors, dieticians, cooks, teachers, consumer associations, agro-



food manufacturers, charities, breeders, operators, farmers, economists, politicians, sportsmen, etc.

Why humans sleep less than other primates

The amount of time we spend awake and asleep compared to our relatives among great apes, monkeys, and lemurs may have played a key role in our evolution.

On dry nights, the San hunter-gatherers of Namibia often sleep under the stars. They don't have electric lights or new Netflix releases keeping them awake. Yet when they get up in the morning, they've slept no more hours than a typical North American or European city dweller who's been lying awake scrolling through their smartphone.

Research has shown that people in non-industrial societies - the closest thing to the type of setting in which our species evolved - average less than seven hours a night, says evolutionary anthropologist David Samson of the University. from Toronto to Mississauga. This is surprising when you consider our closest animal relatives. Humans sleep less than any great ape, ape or lemur scientists have studied.

Chimpanzees sleep about 9.5 hours a day. White-crested tamarins sleep about 13 hours. Three-banded nocturnal monkeys are technically nocturnal, although in reality they are almost never awake - they sleep 17 hours a day.

Samson calls this discrepancy the paradox of human sleep.

"How is it possible that we sleep the least of all primates?" he says. Sleep is known to be important for our memory, immune function, and other aspects of health. A predictive model of primate sleep based on factors such as body mass, brain size and diet concluded that humans should sleep about 9.5 hours out of every 24 hours, not seven. weird," says Samson.

Research by Samson and others on primates and non-industrial human populations has revealed the various ways in which human sleep is unusual. We spend fewer hours sleeping than our closest relatives, and more of our night in the phase of sleep known as rapid eye movement, or REM. The reasons for our strange sleep patterns are still up for debate, but can likely be found in the history of how we became human.

Millions of years ago, our ancestors lived and probably slept in trees. Chimpanzees and other great apes today still sleep in tree beds or temporary platforms . They bend or break the branches to create a bowl shape, which they can line with leafy twigs. (Monkeys such as gorillas sometimes also build beds on the ground.)

Our ancestors came out of the trees to live on the ground and at some point began to sleep there too. This meant giving up all the benefits of arboreal sleep, including relative safety from predators like lions.

It makes sense that the threat of predators could have caused humans to sleep less than tree-dwelling primates.
Humans therefore seem to have evolved to need less sleep than our primate relatives.

The evolution of human sleep is a story of security - specifically, security in numbers. Sleep likely evolved due to the threat of predation when humans began to sleep on the ground. The key to sleeping safely on land was dozing in a group. Some members of the group could sleep while others stood guard. In the safety of this social shell, you could come back and take a nap at any time. These group sleeping shells would have facilitated the journey of our ancient ancestors out of Africa and into colder climes. Groups of humans may have shared simple shelters where a fire could have kept people warm and bugs away. Ancient humans may have traded a few hours

of sleep for sharing information and culture around a crackling fire like we around campfires while camping.

The fossils of our ancestors do not reveal how well rested they were. Thus, to learn more about the sleep of ancient humans, anthropologists study the best indicator they have: contemporary non-industrial societies.

Sleeping in groups, threat of predators or not, is also a natural extension of how people in small-scale societies live during the day, people are almost never alone in these types of communities. After spending the day working on various tasks, a group gathers around a fire while the food is being cooked. They share a meal, then linger by the fire in the dark. Children and mothers gradually move away to sleep, while others stay awake, talking and telling stories.

Our ancestors may have reduced their sleep to a shorter period because they had more important things to do at night than rest.

How long we sleep is a different matter, of course, than how long we wish to sleep.

A 2016 study of nearly 500 people in Chicago found that they spent almost all of their time in bed actually asleep but that on at least one day a week they didn't feel rested. Our sleep problems can be related to stress or abnormal circadian rhythms. Or maybe we miss the crowd we evolved to sleep with? When we struggle to sleep, we may experience a mismatch between our evolution and our current lifestyle.
Basically, we are isolated, and this could influence our sleep. Maybe insomnia, for example, is really hypervigilance - an evolutionary protective superpower when our ancestors slept alone in the savannah.

Development
Over the past 50 years, primary school enrollment has become almost entirely universal in high-income countries. While low- and middle-income countries were still far behind in 1970, they have since made great progress in this area, thanks to the impetus given by the Millennium Development Goals and then by the Sustainable Development Goals (SDGs).). Thus in 2018, nearly 90% of children of primary school age in these countries were enrolled. However, these high enrollment rates do not translate, for many students, into satisfactory learning.

Educational achievements are generally measured by assessments carried out with school children, even if the methods differ from one country to another. The scope of these assessments (age groups and subjects) also varies from country to country. Moreover, as they are carried out in the classroom, children who have not attended school are in fact excluded from them. It is therefore difficult to compare results between countries. This is why, under the leadership of the UNESCO Institute for Statistics (UIS), the Technical Cooperation Group on SDG 4 has defined a common method to compare proficiency levels between different learning assessments.

On this basis and in collaboration with the UIS, the World Bank has defined a new indicator, called "learning poverty", which takes into account both schooling and achievements, by adding the proportion of pupils without minimum reading skills and that of out-of-school children.

This indicator, which is therefore based on a double parameter, assumes that education systems fulfill two important functions: retaining

children in school and guarantee their learning. The closure of schools imposed by the COVID-19 pandemic has highlighted the many essential functions provided by schools: preserving and improving the health and well-being of children, through safety, nutrition and socialization, but also to facilitate the participation of parents in the labor market and, more broadly, to contribute to the

cohesion of society, democracy and peace. These complementary functions reveal the intrinsic value of schooling, in addition to its role in the acquisition of knowledge, and show why it is important to take it into account when measuring learning poverty.

Our indicator focuses on reading skills for two main reasons: they are assessed more than learning in other subjects and they are fundamental to facilitating other lifelong learning. We seek here to analyze how the quality of education can be measured through the prism of learning poverty.

Measuring learning poverty highlights poor education outcomes around the world. Ensuring children's schooling is essential, but insufficient to achieve SDG 4, which aims for quality education. The large number of students who do not read well reveals weaknesses in education systems around the world. Improving education through effective teacher training, a deliberate move towards 'teaching at the right level' and providing students with access to reading materials are some of the prerequisites for improving achievement levels. To make lasting progress in this area, countries need to move beyond teaching techniques alone and adopt a comprehensive approach to the reform of the education system. These include increasing investment in early childhood development, promoting education in children's mother tongues and ensuring accountability at all levels.

The pandemic learning crisis

The COVID-19 pandemic is aggravating the learning crisis. At the height of the health crisis, nearly 200 countries closed their schools. These prolonged interruptions risk leading to poorer learning outcomes in the short term and, in the longer term, harming future skills acquisition and earnings due to higher rates of school dropouts or poorer conditions. socioeconomics within families.

Before the outbreak of COVID-19, the proportion of children unable to read properly was on track to improve slightly by 2030 (from 53 to 43%). But new projections made since the closure of schools indicate that learning poverty rates could increase between 2020 and 2021. Given that it is impossible today to know precisely the full extent of the impact of the pandemic, three scenarios are considered: an optimistic scenario, a intermediate scenario and a pessimistic scenario. Under the pessimistic scenario, i.e. in the absence of sufficiently effective remedial and mitigating measures, learning poverty could increase by more than 10 percentage points from 52.7 to 63.2 percent worldwide.

The strongest effects are expected to occur in South Asia, followed by Latin America and the Caribbean. The impact would be less in sub-Saharan Africa, as the learning poverty rate is already very high there, leaving little room for improvement. In fact, if we take into account the distance that separates students from the minimum level of reading skills, it appears that children in sub-Saharan Africa are among those who suffer the worst learning losses as a result of the pandemic. .

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Unequal countries in an unequal world
Inequalities are pervasive in the modern world, both within and between countries, and both in terms of resources and future prospects.

The focus here is on economic inequality, measured in monetary terms and taking into account price differences between countries. This may seem like a narrow approach to a complex phenomenon, but monetary inequality reflects, reinforces and fuels other non-economic inequalities. It is also correctly assessed through data dating back several decades.

All countries have inequalities, but some more than others.

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For the most recent period, 2012-2017, data was available for 91 countries covering 60% of the world's population. We can divide them into three groups.

The first, made up of 44 countries, recorded growth in both the average income and the income of the bottom 40%, and the latter grew more rapidly. The difference between the two progress rates, represented by the blue bars, is called the "shared prosperity bonus". A positive Shared Prosperity Bonus means that SDG target 10.1 has been achieved during the period.

The second group has 24 countries and has experienced positive growth, but with a negative shared prosperity premium shown by the red shaded bars. In these economies, which include many high-income countries, the income of the bottom 40% has increased, but more slowly than the national average, so inequality has increased. Even though income growth is positive, these countries did not meet target 10.1 during the review period.

In the third group, made up of 21 countries, the income growth of the bottom 40% or the national average was negative. Some of these countries, such as Botswana and Bolivia, experienced a positive shared prosperity premium while average income fell, leading to an unsustainable situation. For others, like Uganda, the evolution has been worse: the average national income has fallen and that of the poorest 40% has plunged even more.

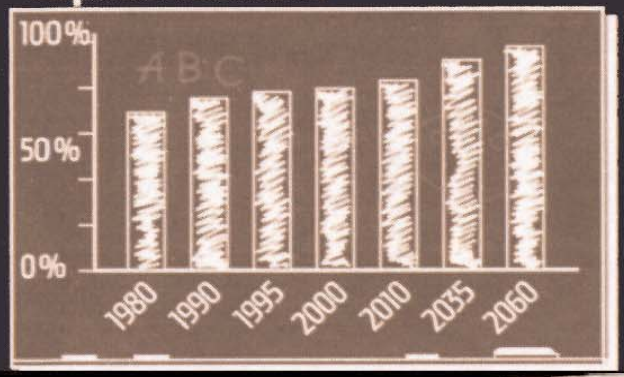
DEVELOPMENT

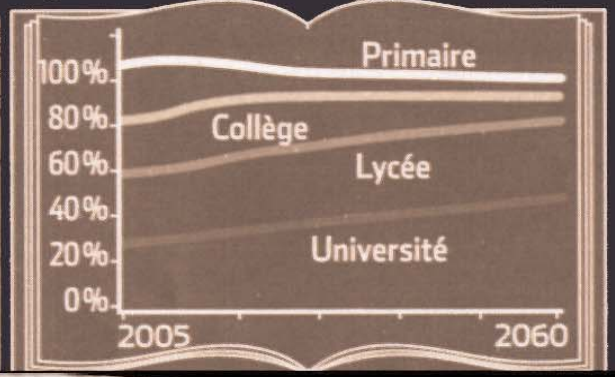
A more complete education for all

By 2060, the literacy rate is expected to reach 98% and access to secondary education will increase slightly. Nearly half of the world's population could go to university

The whole world will be equipped with infrastructure and technology.

Drinking water, electricity, roads, mobile phones, health facilities, are becoming widespread on the planet thanks to the rapid development of countries in the South.





Potable water

2010 **87,8 %** — 2060 **96,1 %**

Electricity

2010 **79,2 %** — 2060 **94,6 %**

Road

2010 **72,2 %** — 2060 **84,9 %**

Mobile

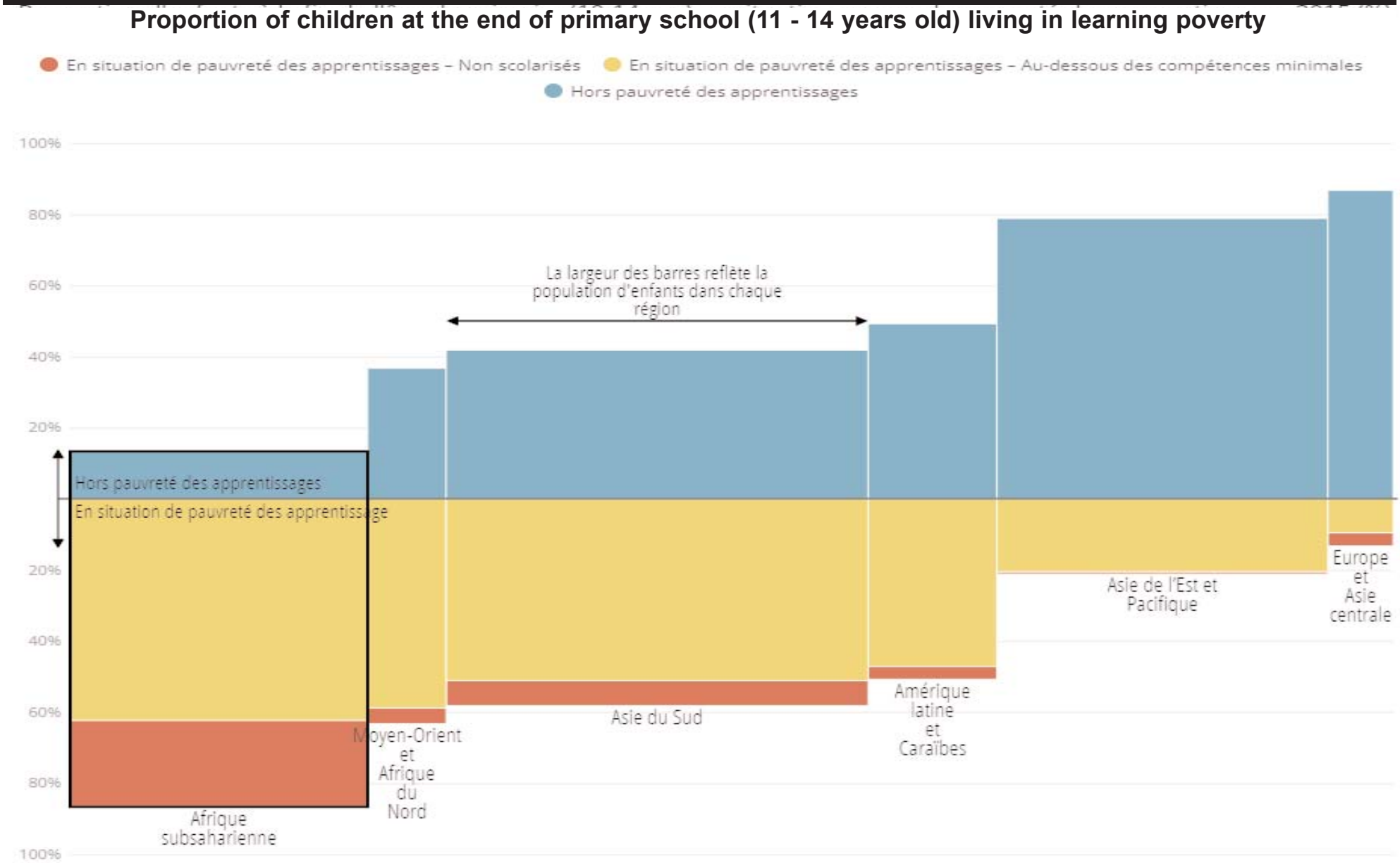
2010 **77,9 %** — 2060 **150 %**

Sanitary

2010 **62,7 %** — 2060 **86,1 %**

Over the past 50 years, primary school enrollment has become almost entirely universal in high-income countries. While low- and middle-income countries were still far behind in 1970, they have since made great progress in this area, thanks to the impetus given by the Millennium Development Goals and then by the Sustainable Development Goals (SDGs).). Thus in 2018, nearly 90% of children of primary school age in these countries were enrolled. However, these high enrollment rates do not translate, for many students, into satisfactory learning.

LEARNING POVERTY IN LOW- AND MIDDLE-INCOME COUNTRIES VARIES BY REGION

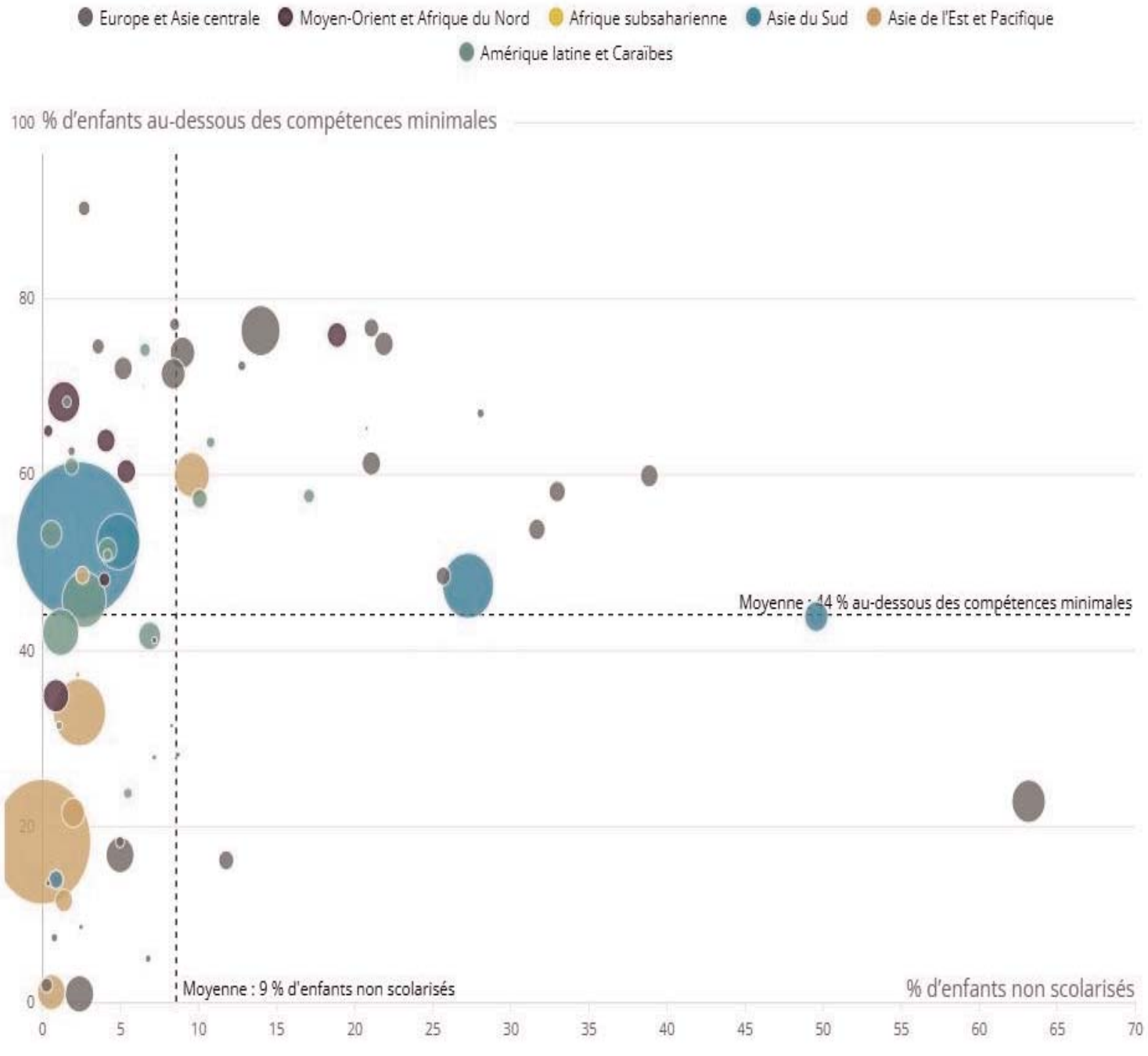

Proportion of children at the end of primary school (11 - 14 years old) living in learning poverty
En situation de pauvreté des apprentissages – Non scolarisés
En situation de pauvreté des apprentissages – Au-dessous des compétences minimales
Hors pauvreté des apprentissages
100%
80%
60%
40%
20%
La largeur des barres reflète la population d'enfants dans chaque région
Hors pauvreté des apprentissages
En situation de pauvreté des apprentissage
20%
40%
60%
80%
100%
Afrique subsaharienne
Moyen-Orient et Afrique du Nord
Asie du Sud
Amérique latine et Caraïbes
Asie de l'Est et Pacifique
Europe et Asie centrale

Educational achievements are generally measured by assessments carried out with school children, even if the methods differ from one country to another. The scope of these assessments (age groups and subjects) also varies from country to country. Moreover, as they are carried out in the classroom, children who have not attended school are in fact excluded from them. It is therefore difficult to compare results between countries. This is why, under the leadership of the UNESCO Institute for Statistics (UIS), the Technical Cooperation Group on SDG 4 has defined a common method to compare proficiency levels between different learning assessments.

On this basis and in collaboration with the UIS, the World Bank has defined a new indicator, called "learning poverty", which takes into account both schooling and achievements, by adding the proportion of pupils without minimum reading skills and that of out-of-school children.

This indicator, which is therefore based on a double parameter, assumes that education systems fulfill two important functions: retaining children in school and

THE LEVEL OF LEARNING BELOW THE MINIMUM SKILLS IS A CONCERN.



Notes : Ces chiffres portent sur les enfants à la fin de l'âge du primaire (10-14 ans). La taille des bulles est proportionnelle au nombre de ces enfants dans chaque

guarantee their learning. The closure of schools imposed by the COVID-19 pandemic has highlighted the many essential functions provided by schools: preserving and improving the health and well-being of children, through safety, nutrition and socialization, but also to facilitate the participation of parents in the labor market and, more broadly, to contribute to the cohesion of society, democracy and peace. These complementary functions reveal the intrinsic value of schooling, in addition to its role in the acquisition of knowledge, and show why it is important to take it into account when measuring learning poverty.

Our indicator focuses on reading skills for two main reasons: they are assessed more than learning in other subjects and they are fundamental to facilitating other lifelong learning. We seek here to analyze how the quality of education can be measured through the prism of learning poverty.

Measuring learning poverty highlights poor education outcomes around the world. Ensuring children's schooling is essential, but insufficient to achieve SDG 4, which aims for quality education. The large number of students who do not read well reveals weaknesses in education systems around the world. Improving education through effective teacher training, a deliberate move towards 'teaching at the right level' and providing students with access to reading materials are some of the prerequisites for improving achievement levels. To make lasting progress in this area, countries need to move beyond teaching techniques alone and adopt a comprehensive approach to the reform of the education system. These include increasing investment in early childhood development, promoting education in children's mother tongues and ensuring accountability at all levels.

The pandemic learning crisis

The COVID-19 pandemic is aggravating the learning crisis. At the height of the health crisis, nearly 200 countries closed their schools. These prolonged interruptions risk leading to poorer learning outcomes in the short term and, in the longer term, harming future skills acquisition and earnings due to higher rates of school dropouts or poorer conditions. socioeconomics within families.

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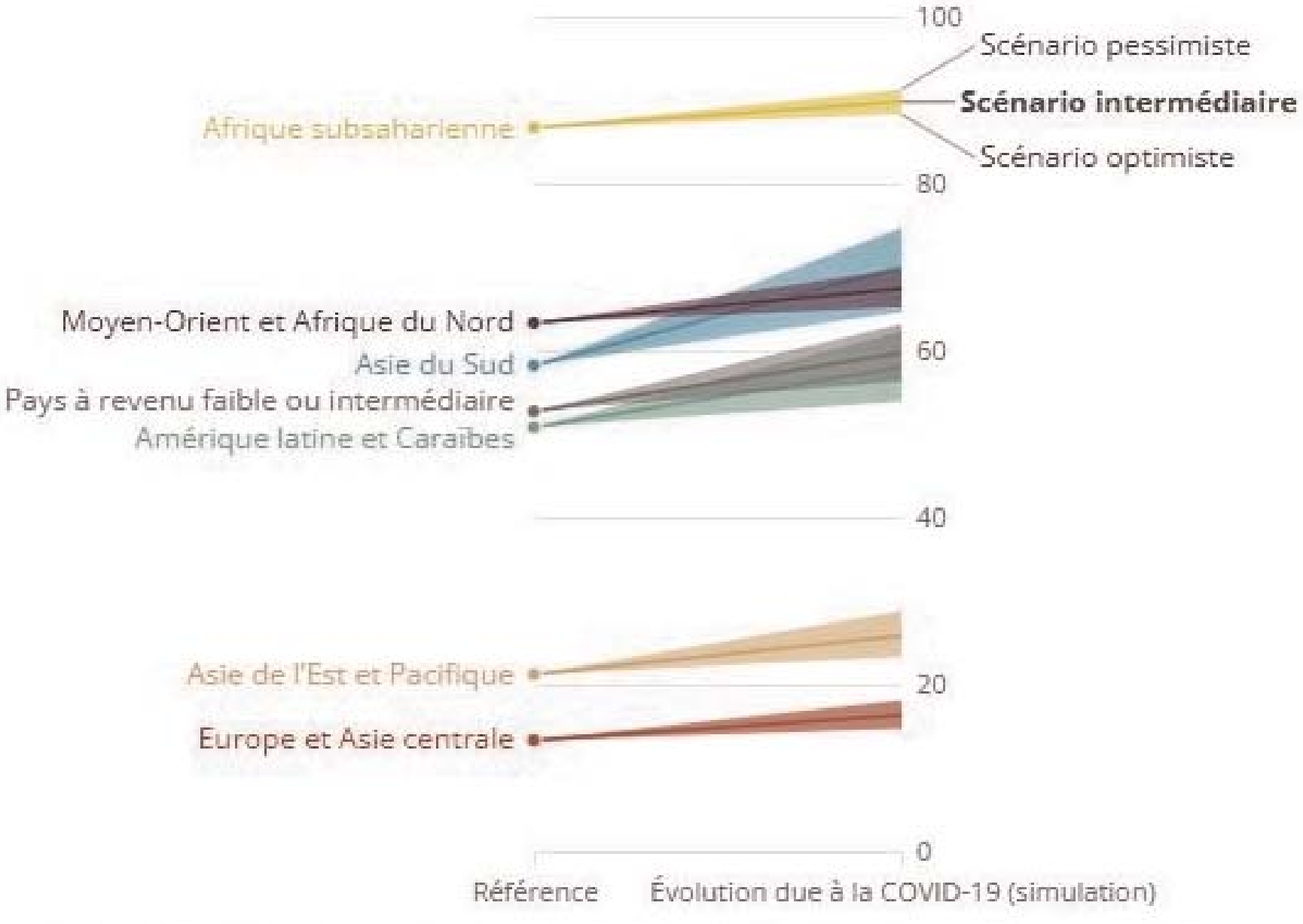
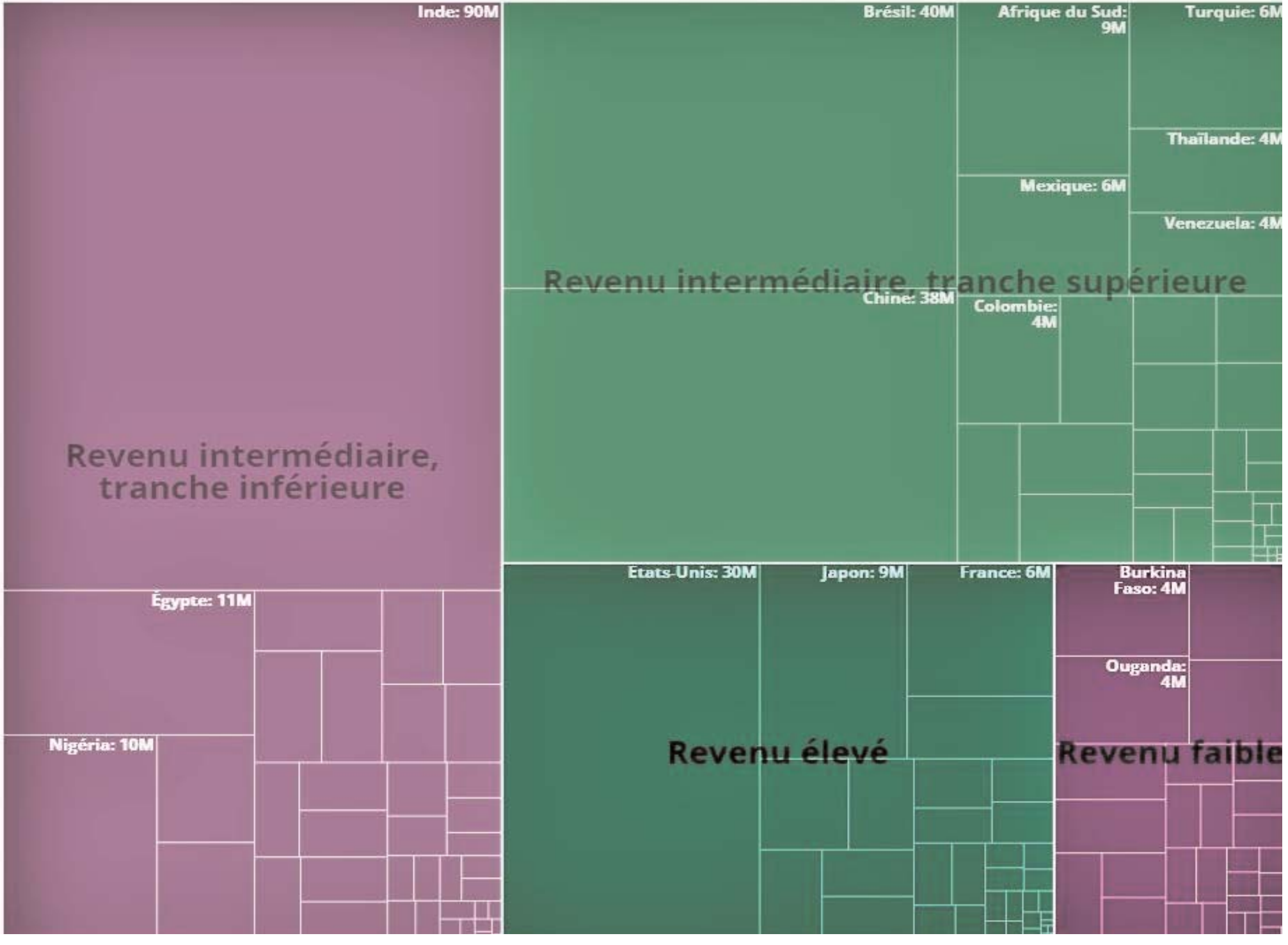
CURRENT AND PROJECTED LEARNING POVERTY



Note : Cette figure ne présente que la situation dans les pays à revenu faible et intermédiaire.

Source : Azevedo, Joao Pedro. (2020). Learning Poverty: Measures and Simulations. Document de travail et de recherche sur les politiques 9446. Banque mondiale, Washington, DC.

370 MILLION CHILDREN HAVE BEEN DEPRIVED FROM MEALS SERVED AT SCHOOL AT THE PEAK OF THE COVID PANDEMIC



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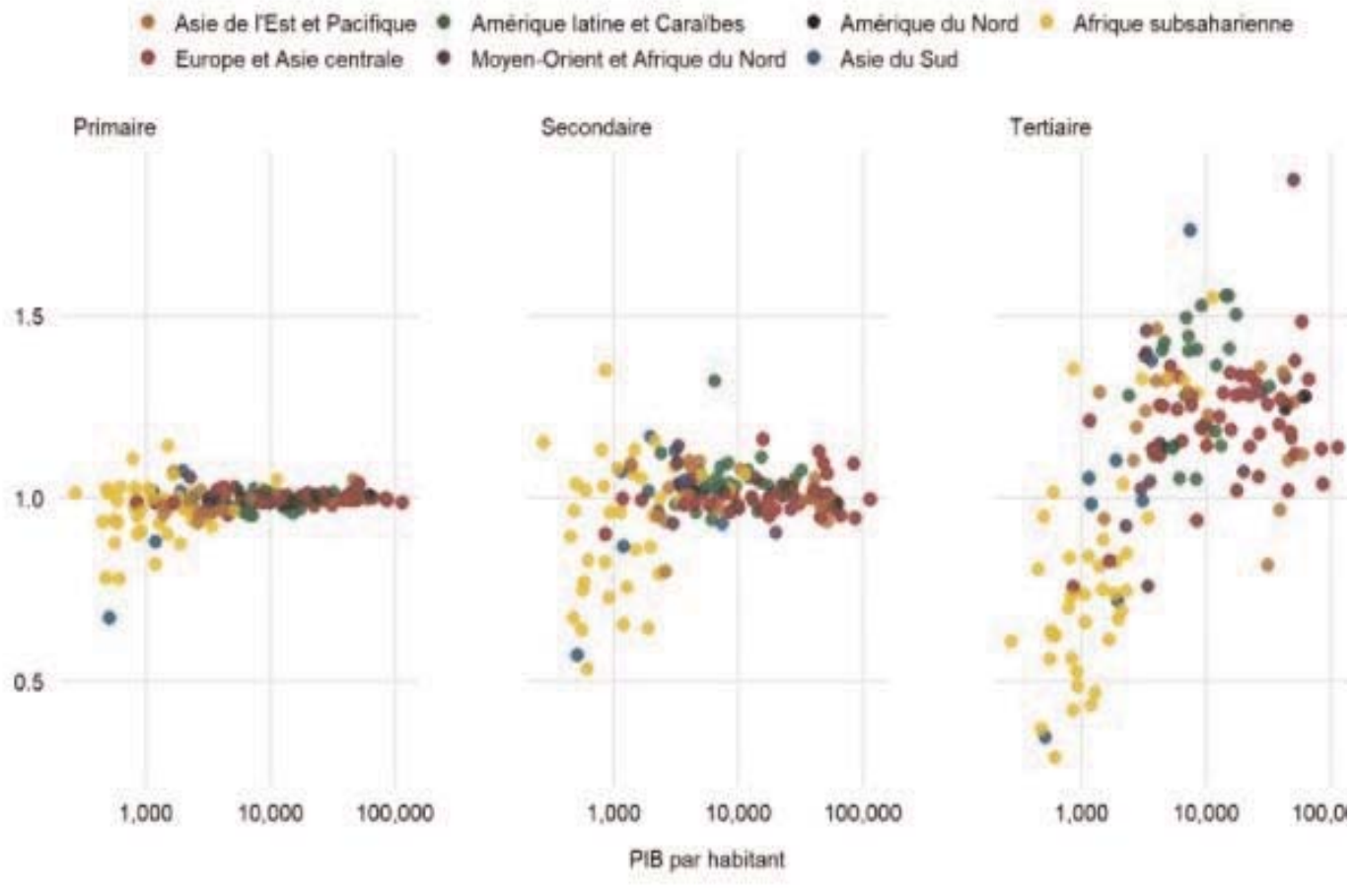
THE GIRLS/BOYS SCHOOLING RATIO IS HIGHER IN THE RICHEST COUNTRIES.

Girls/boys enrollment rate equal in primary and secondary

Primary school enrollment rate, gender parity index, and GDP per capita



Source : Indicateurs du développement dans le monde (SE.ENR.PRIM.FM.ZS, SE.ENR.SECO.FM.ZS,

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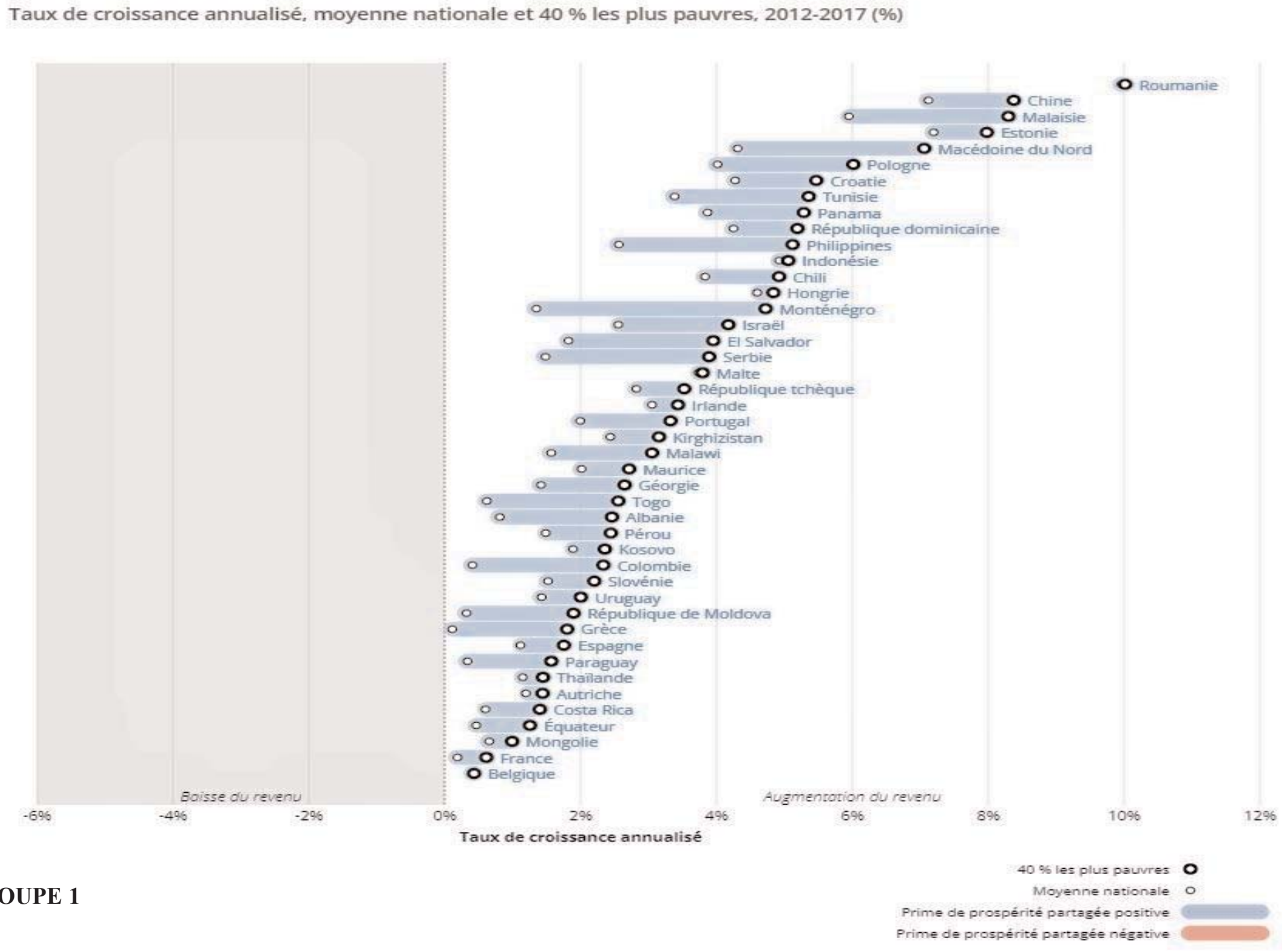
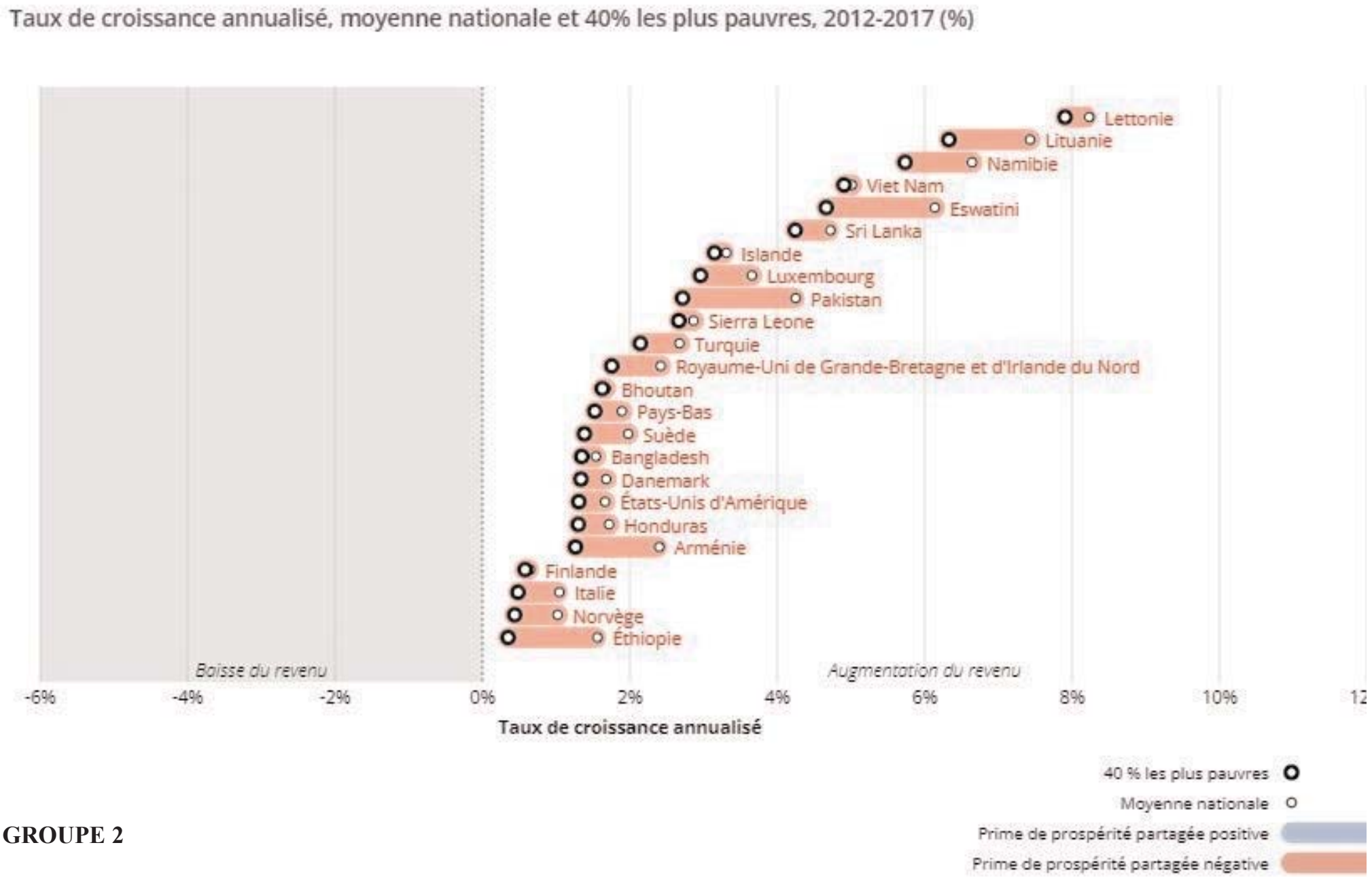
HALF OF THE COUNTRIES EXPERIENCED POSITIVE GROWTH 40% IN THE POOREST COUNTRIES. (2012 - 2017)



GROUPE 1

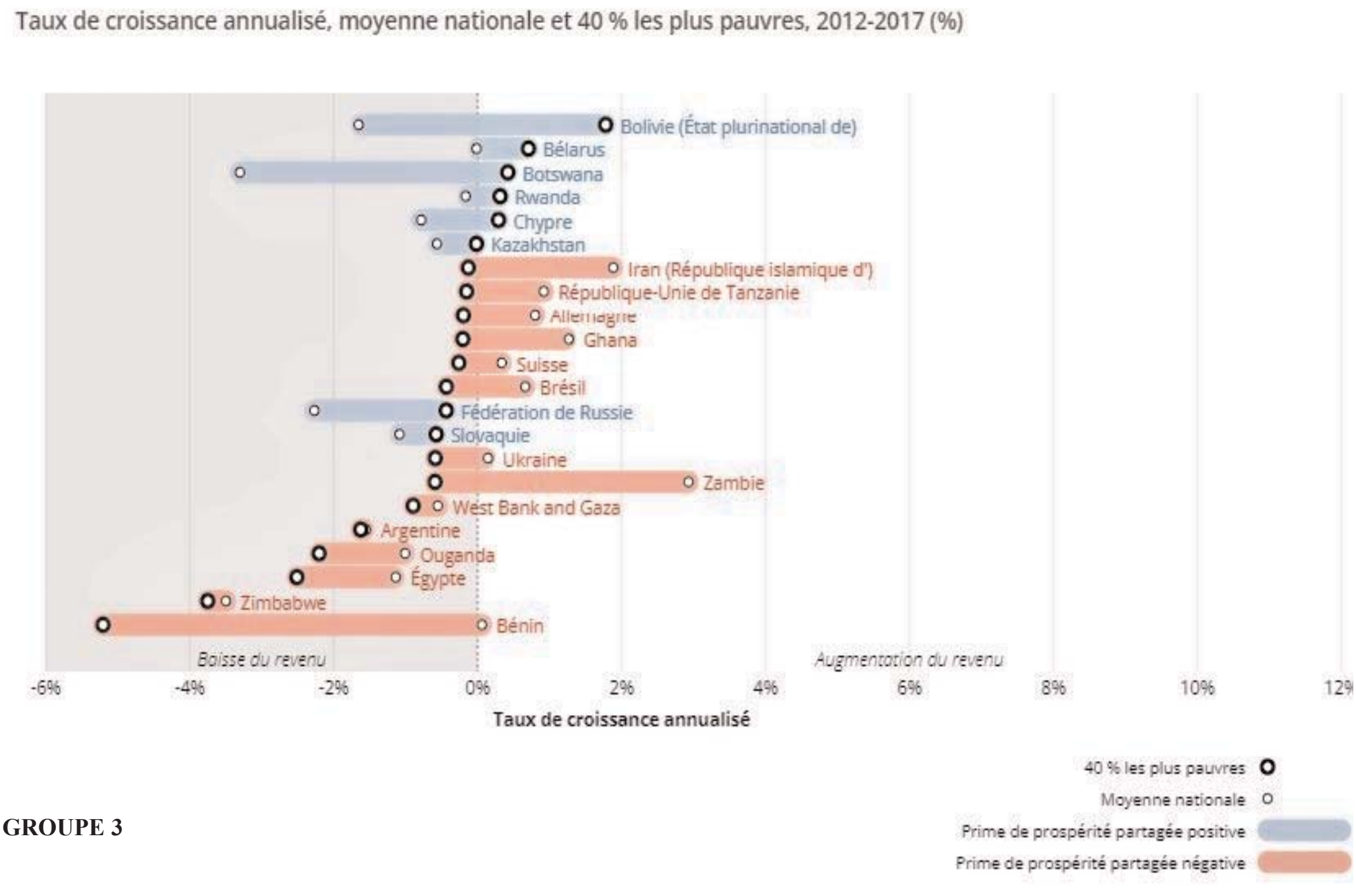
FOR 24 COUNTRIES, INEQUALITY GROWED WHILE INCOME GROWED (2012 - 2017)



GROUPE 2

Source : Base de données sur la prospérité partagée (7e édition), Banque mondiale.

FOR 24 COUNTRIES, INEQUALITY GROWED FOR 40%OF POPULATION

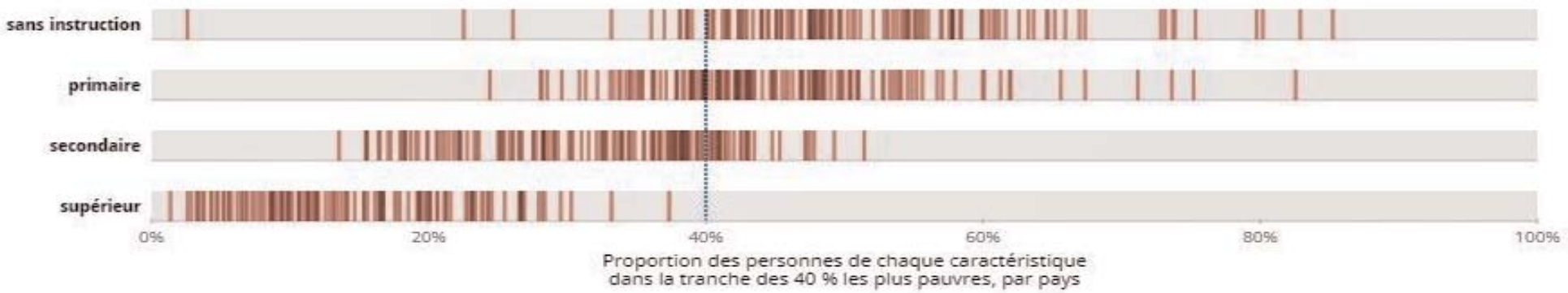


GROUPE 3

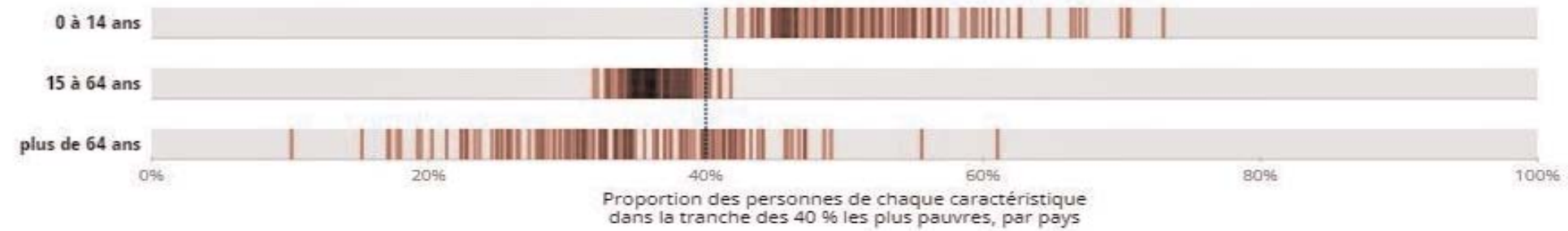
Source : Base de données sur la prospérité partagée (7e édition), Banque mondiale.

PROBABILITY THAT A PERSON WILL BE IN THE POOREST 40% OF HIS COUNTRY

According to level of education

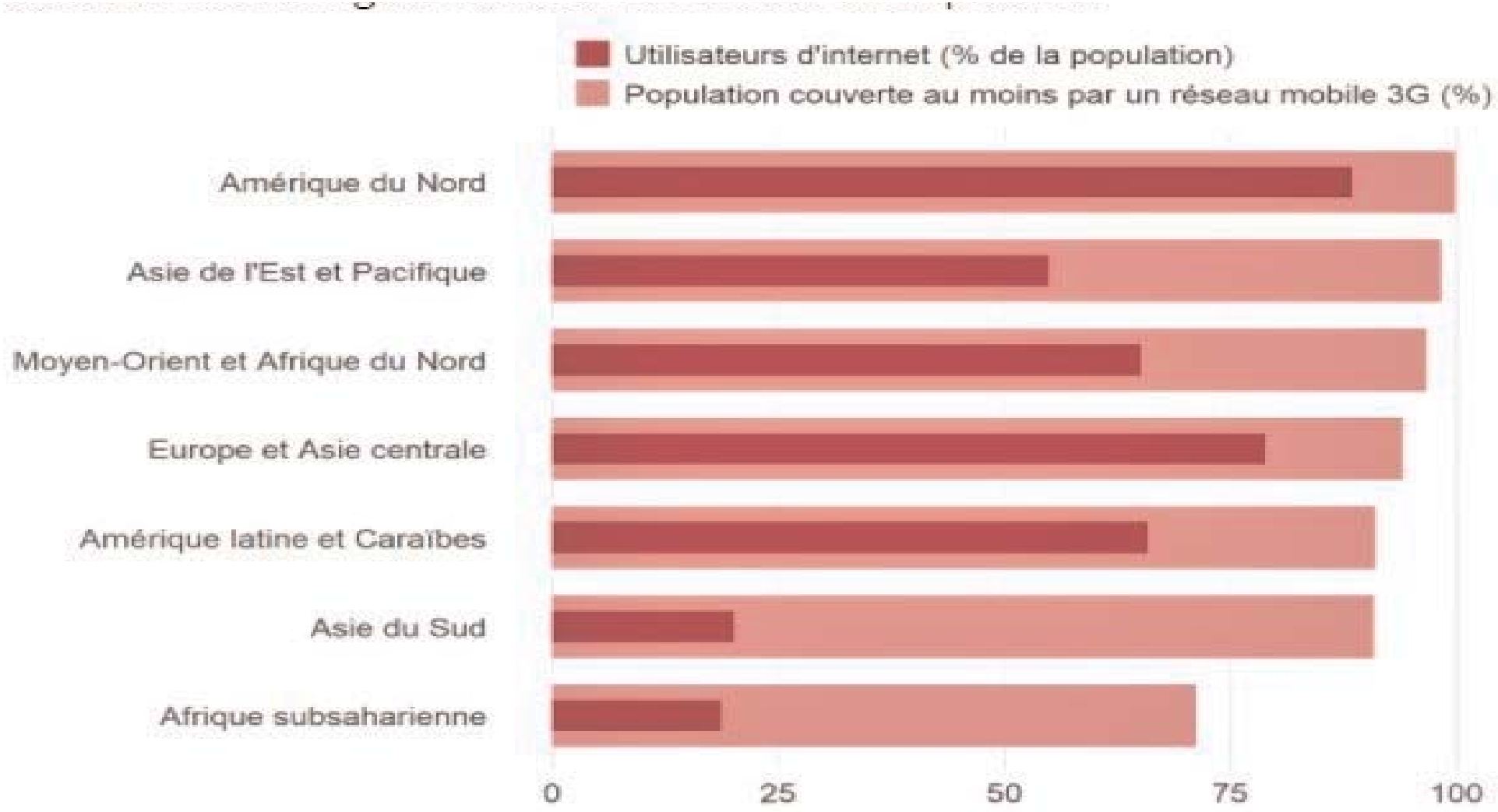


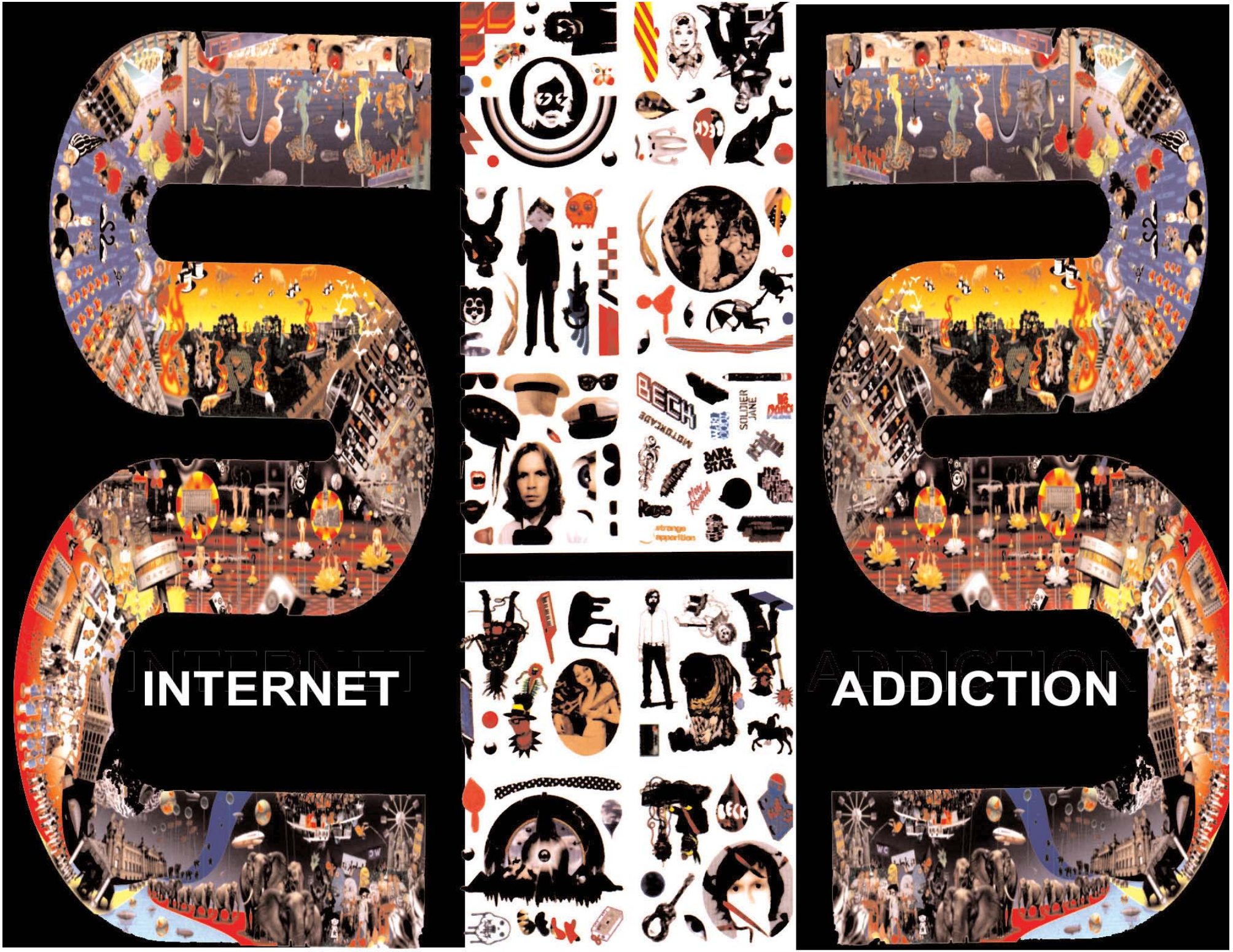
According to age



According to gender

Despite an extension of 3G, many inhabitants of sub-Saharan Africa and South Asia cannot access the Internet (less than a quarter for 80% in North America and Europe)

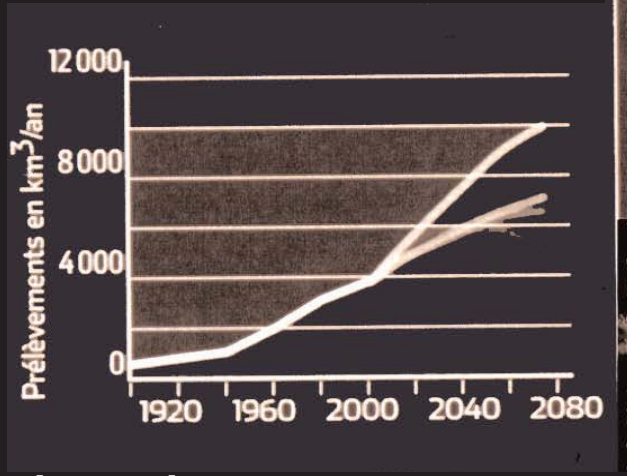



INTERNET
ADDICTION
BECK
MOTORCADE
SOLDIER JANE
DARK STAR
Kaiso
strange apparition

WATER

Its consumption will almost double

According to 4 socio-economic scenarios envisaged, it will be necessary to pump twice as much fresh water in 2080. More than half of this water will be used for the irrigation of agricultural land.



Increasingly unbalanced access

Climate change will modify, downwards or upwards depending on the region, the quantities of water available. While India and Africa will see their needs greatly increase due to their population growth, access to drinking water will be more difficult.

Food

Yields will have to grow

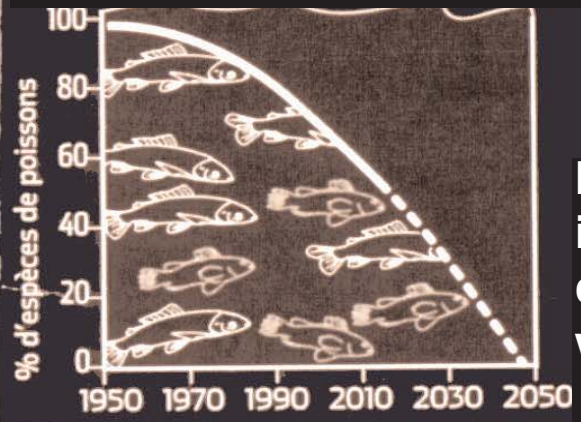
Feeding 9 billion people will require improving agricultural yields. These should progress but at a slower pace than in the past. The area of cultivated land will increase little.

Did you know ?

4,000 people die of hunger every day about every 4 seconds despite donations from citizens

Extremely threatened fishing stocks

By extrapolating the trend already observed since the 1950s, overfishing could lead to the total collapse of fish stocks in the oceans by the year 2048



Cultivable area per person

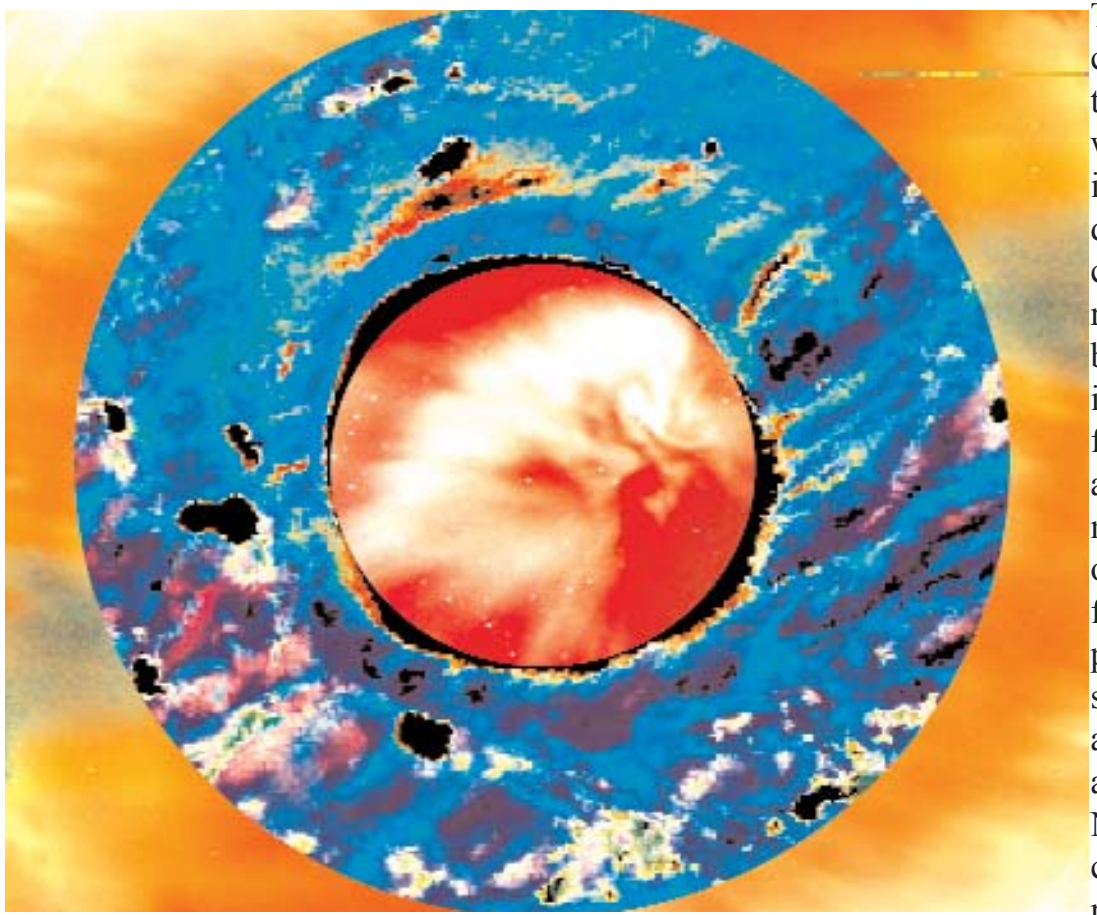
x2

Meat production is expected to double worldwide by 2050,

The water cycle

Satellite data reveals a disturbing change in the Earth's global water cycle. The water cycle is the course that takes place naturally between the great water reservoirs of our planet. The energy of the Sun and the heat are at the origin of this course, by favoring the evaporation of water and its displacement in the atmosphere.

Fresh water is becoming increasingly fresh and salt water is becoming increasingly salty, this is the finding of a study by Spanish researchers from the Institute of Marine Sciences published in Nature. Climate prediction models had already considered this phenomenon, but not so quickly. As global temperatures rise, more evaporation occurs from the surface of the oceans, leaving surface waters saltier and adding additional moisture to the atmosphere.



The water cycle speeds up by 7% for each degree it increases Climate change also results in a general weakening of winds. These less strong winds allow the surface waters to warm up, without allowing the hot surface water to mix with the cooler water below: the surface waters evaporate and the salt therefore remains trapped on the upper level. The most recent climate prediction models estimate that for each degree of warming gained, the water cycle accelerates by 7%. Concretely, this means that wet areas will be 7% wetter, and dry areas will be 7% drier. Estimates that agree with the latest IPCC forecasts on the envisaged consequences of climate change: if humanity manages to limit the rise in temperatures to 2°C compared to pre-industrial levels (knowing that we are already at 1.2 °C), extreme weather phenomena will anyway be 14 times stronger compared to what they were at the beginning of the industrial revolution.

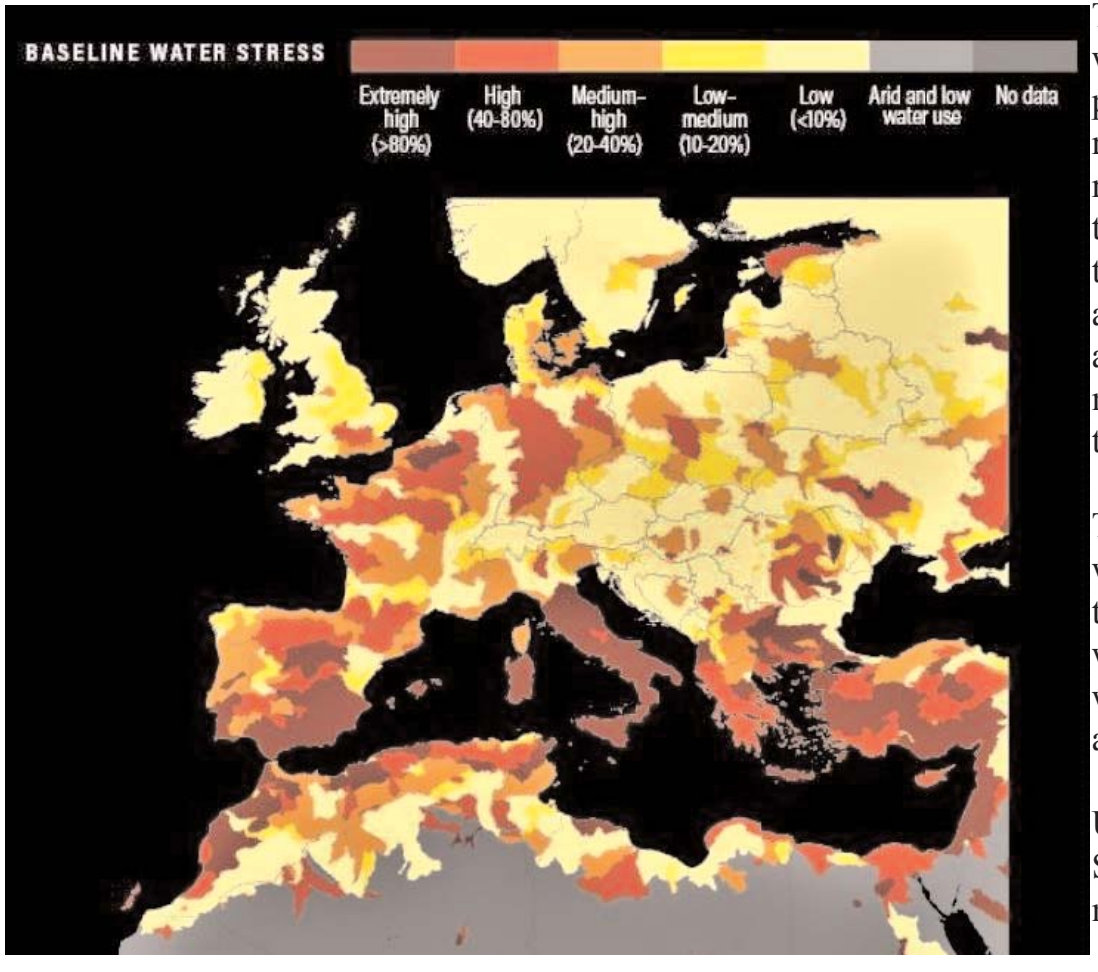
More droughts or more floods depending on the region

This humidity will increase precipitation in certain regions of the world, and dilute the fresh water in rivers and lakes, making them even less salty. This development could also supercharge episodes of torrential rainfall. Wetlands will therefore be even wetter, with more intense and more frequent rainfall leading to more flooding, and drylands will suffer even more from drought. A quarter of humanity already suffers from lack of water, and the prospect of more frequent and severe droughts could lead to an unprecedented global crisis, according to the United Nations. In the polar regions, climate change has already resulted in increased rainfall in the spring, melting the snow even faster.

Shortage awaits

Since the beginning of this year 2022, the accumulations of precipitation have been in deficit, the situation will not improve. With climate change, we can expect some 84% of the world's cultivated land to become increasingly water-scarce by 2050. Worse, 60% of it is expected to experience shortages.

Once unthinkable, water shortages are becoming commonplace. So much so that nearly a quarter of the world's population, living in 17 countries, is today in a situation of serious water shortage, close to the famous "zero day" during which no more water will come out of the tap. This is what a report from the World Resources Institute (WRI) tells us.



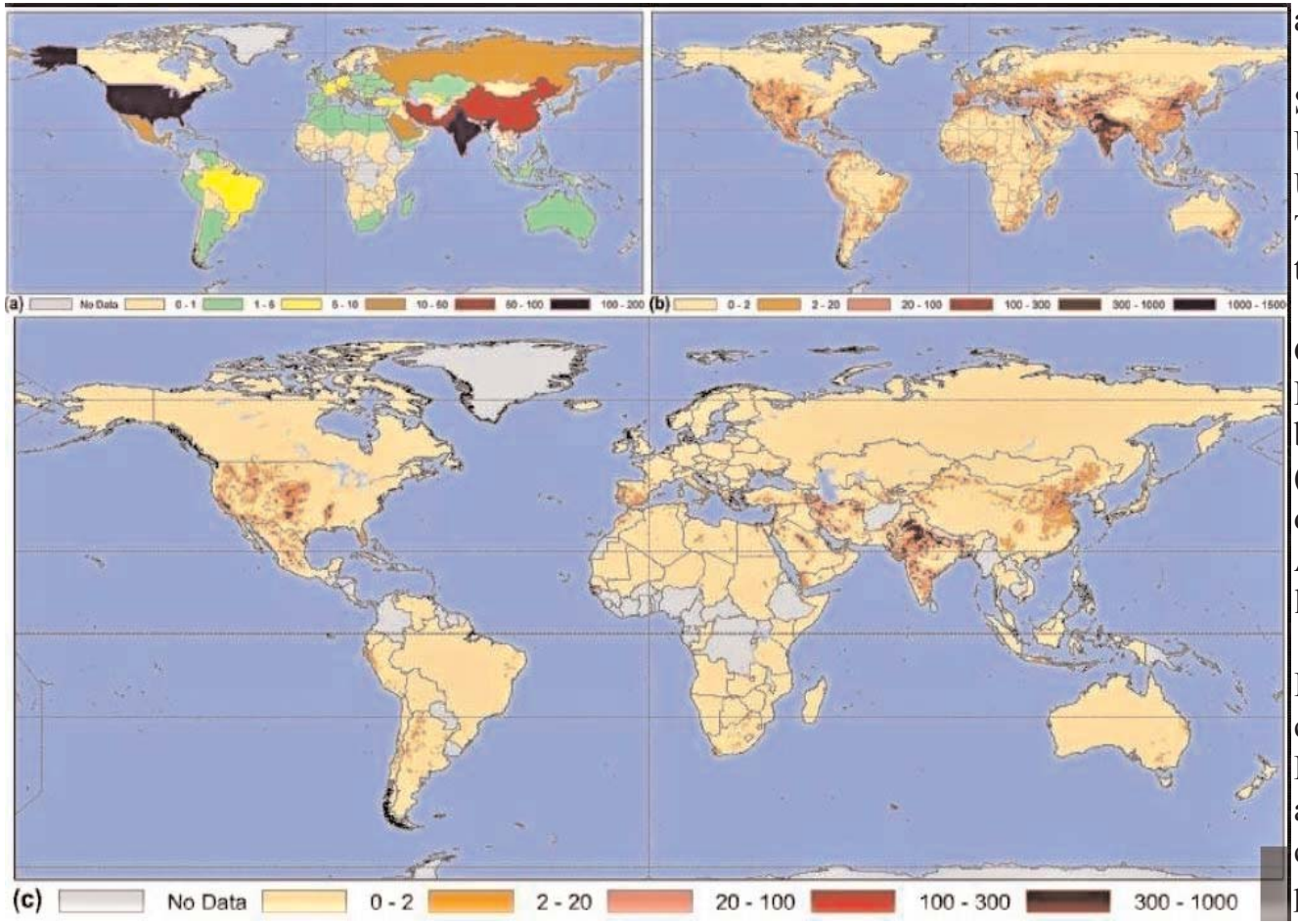
"Agriculture, industry and municipalities absorb 80% of the available surface and groundwater in an average year" in the 17 countries concerned -- Qatar, Israel, Lebanon, Iran, Jordan , Libya, Kuwait, Saudi Arabia, Eritrea, United Arab Emirates, San Marino, Bahrain, Pakistan, Turkmenistan, Oman, Botswana and India--mainly located in the Middle East and North Africa, the report says. Twenty-seven other countries are on the list of countries with high water shortages, including Greece, Spain, Portugal and Italy.

Water scarcity is the biggest crisis, which no one talks about. Its consequences take the form of food insecurity, conflict, migration, and financial instability.

Until then, most studies had focused only on blue water resources. This also takes into account issues related to green water. Green water is more precisely the portion of rainwater available to plants in the soil. This availability is of course dependent on rainfall. It also depends on the amount of water lost due to runoff and evaporation, agricultural practices, vegetation, soil type and slope of the land. Thus with the increase in temperatures and the expected changes in precipitation patterns, all in addition to the intensification of agricultural practices, the availability of green water will change. The researchers estimate that these changes in green water availability are expected to impact around 16% of cropland worldwide.

The water used in agriculture can have several origins. Green water comes from precipitation. They are temporarily stored in the ground. Blue water is pumped from rivers, lakes or groundwater, but in a sustainable way. The third source corresponds to water extracted from reserves which are renewed little or not at all.

Unsustainable crop irrigation management
Scientists used geographic, hydrographic and satellite data to model and map water use in global agriculture. Their program



Map (a) shows the quantity of water extracted from the ground by the various countries in 2000 (in km3/year). The second infographic (b) shows the water demands for irrigating crops worldwide (km3/year). The bottom representation (c) illustrates how accurately the model can represent regions that pump water from underground to irrigate crops. This map is much more accurate than representation (a). It helps to better understand the problems. © Wada et al. 2012, Water Resources Research

is not limited to a country's borders. It makes it possible to study each region of the Globe. The important results are listed below.

In 2000, nearly 20% of irrigation water came from sources that are unsustainable. India alone extracted 68 km3 of this resource in 1 year. It is followed by Pakistan (35 km3/year), the United States (30 km3/year), Iran (30 km3/year), China (20 km3/year), Mexico (10 km3/year) and finally, Saudi Arabia (10 km3/year). These waters are mainly used in semi-arid regions.

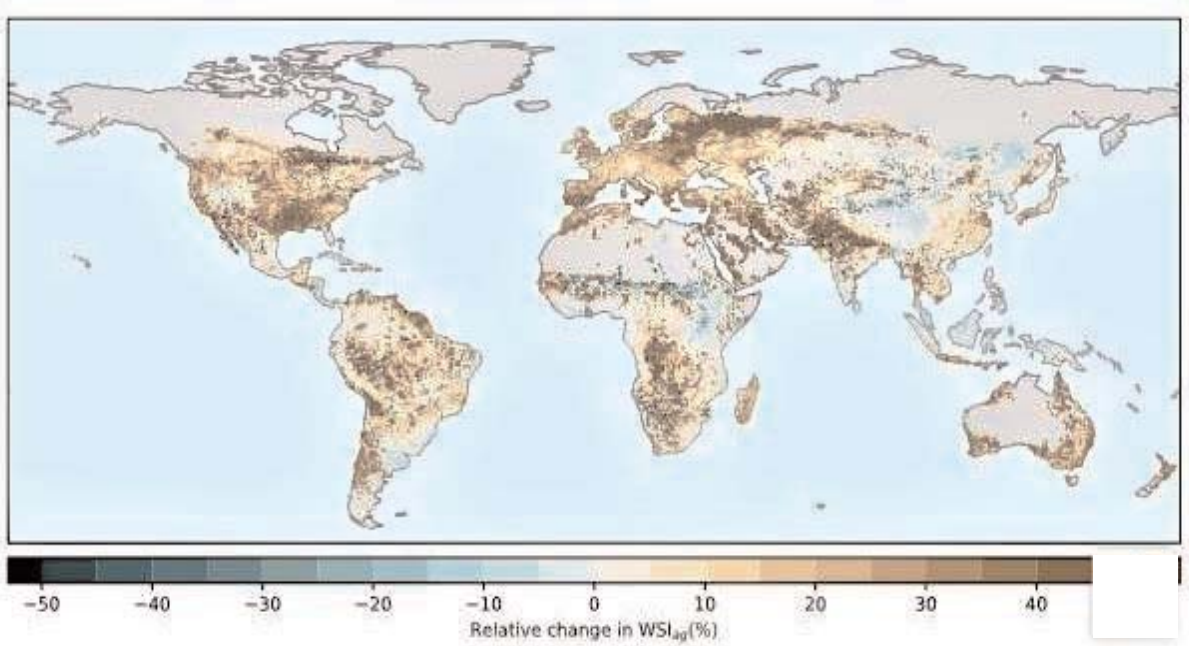
Some countries mainly use fossil waters. Unsurprisingly, these countries are: Qatar, United Arab Emirates, Saudi Arabia and Libya. They are often cited as an example to illustrate the phenomenon of the greening of deserts.

Global economic consequences

More surprisingly, some countries using mainly blue water (lakes and rivers) and green water (rainfall) could find themselves in water deficit due to global warming (reduction in rainfall). Algeria, Morocco, Spain and Italy are particularly concerned.

In the event of water shortages, the economic consequences would be felt on a global scale. Doesn't France import huge quantities of fruit and vegetables from Spain and Morocco, two countries mentioned above? What would happen to food prices if they were to become scarce?

A decrease in global agricultural production could also have serious health consequences as the population continues to increase... Agriculture remains the main weak point, absorbing on its own 72% of freshwater resources. According to another report by the European Court of Auditors, European agricultural policy promotes water wastage, "with funding going to support crops that require large amounts of water such as rice, nuts and fruits and vegetables, without geographical restriction, and therefore also in water-stressed areas". In addition, "exemptions from water restrictions are generously granted to farmers, including in regions under water stress".



Agricultural land increasingly arid due to lack of water 2050

Wetlands are disappearing even though they are essential to our survival.

Essential allies in the fight against global warming, wetlands are highly threatened and degraded all over the world. The United Nations estimates that 35% of wetlands have disappeared since 1970, even though they have many unrecognized benefits, such as disaster mitigation, carbon sequestration and human health. 40% of species in the world live or breed in wetlands. Very complex to define even for experts, because they come in all shapes and sizes, wetlands are flooded ecosystems, permanently or intermittently, hosting a specific biodiversity.

The Convention on Wetlands (or Ramsar Convention) has just updated its latest report on the state of wetlands in the world and the importance of safeguarding them. While all eyes are focused on the degradation of the Amazonian forest or the disappearance of glaciers, wetlands are the most threatened ecosystems on the planet: marshes, peat bogs, wet meadows, lagoons, mangroves and other hot spots. Water is currently disappearing at a rate 3 times faster than forests. 36% of wetland-dependent species are globally threatened. Yet little known, the role of wetlands is crucial in the functioning of the Earth: reservoir of biodiversity, but also disaster mitigation, human health, and carbon sink.

The wetlands remain, however, tainted by their bad historical reputation and their muddy and inhospitable appearance. In folklore, swamps are "associated with will-o'-the-wisps", Yves Jacob reminds us. "In the subconscious of man, the wetland remains an unhealthy place, where parasites, pests and diseases thrive.

Threats: agriculture, livestock, pollution and climate change

Deforestation, pollution, exploitation and climate change... The various affronts suffered by natural environments are assiduously denounced, especially when it comes to forests or oceans, but the less glamorous marshes, bayous, peat bogs and others are much more neglected. lakes, commonly referred to as "wetlands". However, these are the hardest hit by human activities: in a century, 54% of wetlands have been destroyed, warns a 2018 report by international experts from the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES).).

Wetlands have a global surface area of 1.2 billion hectares in total; this gives a territory larger than that of Canada. But in just 50 years,

they have already lost a third of their total surface. Dramatic finding since wetlands are the most important reservoirs of biodiversity on the planet

Uncontrolled land use (especially agriculture and livestock) is the primary driver of wetland degradation, while the Convention on Wetlands insists that "the future of sustainable food production depends on healthy wetlands and their wise use". Agriculture is responsible for the disappearance of more than half of wetlands since 1970. Then come the overexploitation of livestock, plants, pollution, invasive species, but also logging, as well as hunting. and the fishing of species essential to the functioning of these areas. And the Convention's predictions are rather grim for the future: all of these threats to land and biodiversity "are projected to continue or worsen in many future scenarios, in response to indirect factors such as rapid human population growth, unsustainable production and consumption and related technological development."

While wetlands are the bane of some, and arouse the indifference of others, they disappeared at a rate three times faster than forests between 1990 and 2015, according to the 2018 report of the Ramsar Convention. In Southeast Asia and in the Congo region of Africa, oil palm plantations, much criticized, are the main culprits of their destruction. They also face, across the globe, the risk of drying up (water is drawn for irrigation), filling up, urbanization and, of course, pollution.
Wetlands are also particularly affected by the consequences of climate change: sea level rise, coral bleaching and hydrological disruption. Of all the world's wetlands, arctic and mountain wetlands are more exposed to climate risks. In areas with a rather dry climate, which will suffer even more from drought with global warming, water stress is becoming more and more important, drying up many wetlands essential to biodiversity and the human population.

Another geographical area where the deterioration of wetlands is clear is the Mediterranean region. Since 1992, the marine biodiversity of the Mediterranean has decreased by 52% and its freshwater biodiversity by 28%. The flow of rivers in the Mediterranean basin decreased by 25 to 70% between 1960 and 2000, with repercussions on seasonal wetlands. Intensive agriculture consumes two thirds of the fresh water resources of the Mediterranean. With more than 42% of the Mediterranean population settled on the coast, settlements, industry and tourism are degrading coastal wetlands and the demand for water is increasing.

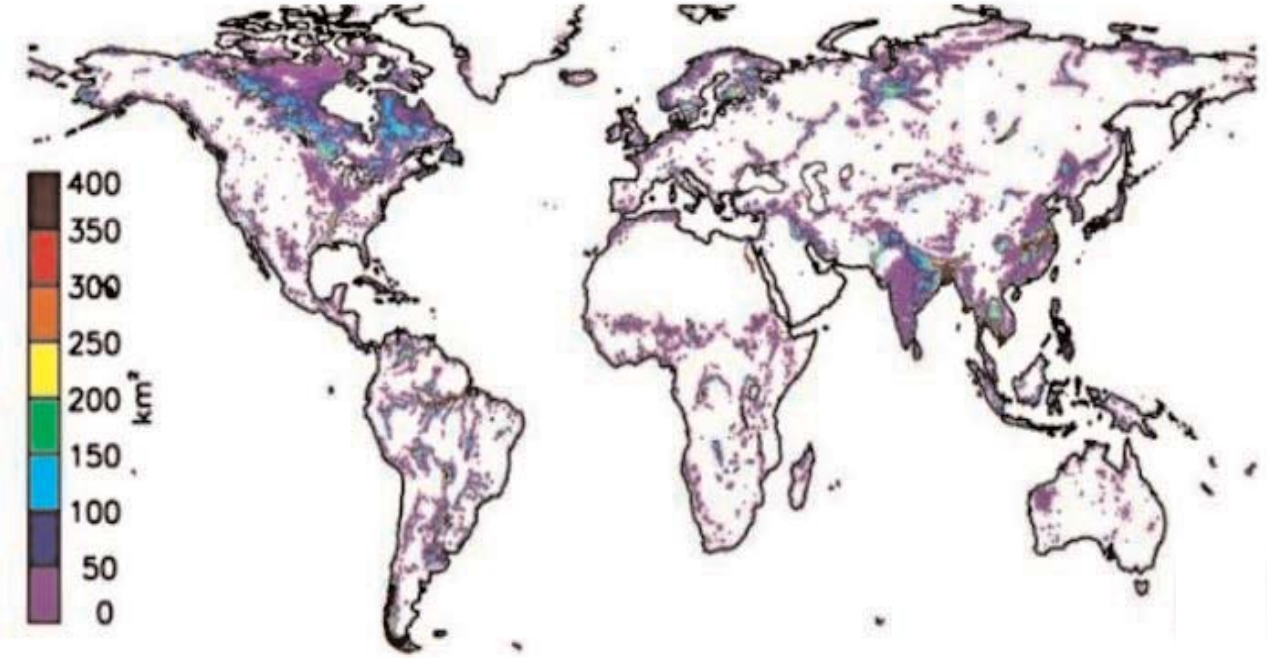
Wetland: a first worrying world map

The unknown benefits of wetlands
The interest of safeguarding and restoring the planet's wetlands is multiple and often totally unknown to farmers, breeders and more generally to local populations. The Convention estimates that 4 billion people (out of a world population of almost 8 billion) are directly dependent on wetlands for their survival. The economic value of wetlands for the services they provide to humanity is estimated at 47,400 billion dollars per year!

Coastal wetlands, such as mangroves, sequester carbon dioxide 55 times faster than tropical forests. Peatlands, which cover only 3% of the world's surface, sequester 30% of the carbon present underground. Peatlands and coastal blue carbon ecosystems (salt marshes, mangroves, seagrasses, etc.) in good condition are very effective carbon sinks, but if they are degraded, they become important sources of greenhouse gases. Greenhouse.
Finally, the unavoidable climate change and its consequences, in particular the rise of the oceans, poses a particular problem for coastal wetlands. A coastline retreat of 80 meters has been observed in 50 years. We expect this to continue.

One of the objectives of the United Nations is to restore 50% of the peatlands destroyed by 2030. Mangroves, coral reefs and seaweed also play the role of barriers that mitigate coastal submersion in the event of a storm. and tsunami. On land, peat bogs, ponds, rivers and

water points in general absorb excess water in the event of flooding and retain it in the event of drought. These ecosystems are part of what are called Nature-Based Solutions.



Extent of flooded areas, on average over the year, estimated by satellites, between 1993 and 2007 (areas are expressed in km2; each pixel covers 773 km2). A 6% decrease in wetlands in fifteen years © Fabrice Papa

Good human health also depends on well-managed wetlands: "The control of emerging zoonotic diseases depends on the preservation of intact and well-managed ecosystems and local biodiversity. Adopting an ecosystem approach to wetlands can have health benefits for all. The degradation of ecosystems and the senseless wildlife trade increase the risks of devastating pandemics and three-quarters of new diseases are of zoonotic origin". In addition, "water-related diseases, such as infantile diarrhoea, carried in unsanitary waters, are also favored by poor management of wetlands and kill millions of people each year".

To better protect these environments, a watchword: inform - as much about their hidden wealth as about their interest for Man. Although they occupy only 4% of the earth's surface, wetlands support more than a billion people in the world. They provide a multitude of resources, including drinking water, raw materials (reeds, gravel, etc.), food, and render a great many services. They are also "as productive as the forests", remarks David Héritier. They are also home to as yet unknown plants that may be useful for the development of new drugs.

The status of vital resource attributed to it should prohibit the very notion of a water market. Who, in fact, would dare to trade in water, the source of life?

Will water always be considered as "untouchable heritage of humanity"? Not so sure, because another vision comes to counterbalance this image. While the reserves are running out (in Central Asia, for example, the evolution of the water level of the Aral Sea is worrying), some wonder whether it would not be better to set a price for this resource, at the risks making it the "blue gold" of tomorrow.

Putting a price on water would ensure its conservation and would facilitate the development and maintenance of infrastructures, thus giving access to water to a large proportion of humanity. This would facilitate exchanges between countries sharing common resources, with a view to better exploitation and regulation of this source of wealth.

However, many reservations qualify this vision. Without strong control, making it possible to ensure that the multinationals which will

share the market will not charge inflated prices, there is a risk that water will turn into "blue gold", in the same way that oil is qualified as " black gold ".

States will no longer be in charge of distribution. Large multinationals will take their place. They will then also be responsible for maintaining a healthy distribution network. However, this essential task would be threatened if one of these water giants were to experience financial problems...

Water, a weapon of war in the world

Water has become a major geopolitical issue. The water war is raging around the world: in the Middle East, but not only. The border between the United States and Mexico, for example, is affected by this type of conflict.
The Colorado is a capital river for the southwestern United States and Mexico. It has thus become one of the most regulated and most developed, but the sharing of waters is a source of conflict between the United States and Mexico.

The Colorado originates in the Rocky Mountains of the state of Colorado and travels nearly 2,300 kilometers before emptying into the Gulf of California, Mexico. Originally, it was a swirling, untamed river. At one time it even rolled out of bed in California, where it formed what is now Lake Salton.

Mexico - USA
Sharing of waters and conflicts between the United States and Mexico
Mexico, under a 1944 agreement, must supply the southern United States with 450 billion liters of water per year. This treaty provided for a sharing of waters between Mexico and the United States, with Mexico providing waters from the Trio Grande and the United States leaving a minimum flow to Colorado. But since this agreement, the Rio Grande has dried up and the United States is seeking to recover some 200 million m3 of water from the Colorado which is infiltrating into Mexican soil by planning to cement the All American Canal located at the border.

This part of the basin includes the lower section of the river, the boundary wetland complex that lies in the delta and feeds the Sea of Cortez (Gulf of California), and the larger Sonoran Desert ecosystem. This water therefore feeds these wetlands and Mexico has nothing to say about the environment! However, the recovery of this water would definitely dry up the mouth of the river...

However, despite the drought that raged and a meeting between Presidents Zedillo and Clinton in June 2000, the United States reminded Mexico of its contractual commitments without conceding any arrangements to take account of the seriousness of the situation.

Canada-USA
Exports, diversions and river diversions: the United States is completely water-hungry and is convinced that its money can ensure its supply, but things can change, especially with regard to the Canadian Great Lakes.

"Before examining the risks of seeing ourselves dispossessed, we must first remember that massive export, in ecosystemic terms, is not a viable solution. There is no surplus water as such. in an ecosystem (...) "The great outflows from the Great Lakes provide a necessary supply of fresh water to fishing grounds as far away as the Gulf of Maine" (CMI, 1999).

Nevertheless, insofar as the pressure of the United States to feed in our waters is pressing, we must ensure that we have all the tools both to protect it and to rigorously assess the long-term impacts of any extraction and diversion. massive. (...) In the case of the Great Lakes, the fierce opposition to any massive bulk water export proj-

ect by diversion is due to the fact that the renewal of this reservoir is less than 1% per year, already absorbed by industrial and urban activities.

Second, the massive export of water is of little value in terms of sustainable development. Especially since transport costs are prohibitive compared to those of seawater desalination. At best, transporting water will quench the thirst of the rich, in the richest countries without relieving the populations or satisfying subsistence and development needs. With regard to Canadian waters, it is the United States that would have the financial means for operations justified by the shortages attributable to their faulty strategies for the development and management of water resources.

Indeed, and thirdly, it is first upstream that it is necessary to correct the bad water management strategies, responsible for the lack of water supply, to avoid swallowing up fortunes and aggravating the shortages in the long term. of water. The efforts of the "eco-water-citizen pan-American" movements for responsible water management therefore deserve to be encouraged. (...) With NAFTA and the FTAA (free trade agreements), the risk, in the coming decades, of diversion of water, especially from Quebec and British Columbia, will result in particular from poor management strategies water resources in the United States.

The Ogallala water table

The Ogallala water table

The example of the Ogallala water table is eloquent. These underground waters occupy 580,000 km2, as much as Lake Superior, in the Hautes-Plaines area. These vast steppes with extreme climates encompass western Texas, Oklahoma and New Mexico, to the south, Kansas, part of Colorado and Nebraska, and, to the north, South Dakota. The pumping of the Ogallala aquifer has made these semi - arid plains one of the breadbaskets of the planet, which produces almost half of the beef in the United States.

Within 25 or 30 years, overexploitation will dry up this aquifer or make its exploitation prohibitive, leading to a collapse for agriculture and livestock farming in these six states and the dozen cities that depend on them. If the aquifer dries up, plans have been made to divert water from the Mississippi Gulf, through four major rivers and 150 rivers, requiring the power of twelve medium-sized nuclear power plants, a billion-dollar project, calculates Mr. DeVilliers. An even crazier plan, he continues, water planners have considered diverting the course of Canadian rivers flowing into the Arctic Ocean southward and into the Great Lakes, thereby redeveloping the entire North American continent, a plan that no one thinks is feasible.

The International Joint Commission of the St. Lawrence and the Great Lakes also affirms that there are currently no serious plans for a major diversion or significant water withdrawal by truck or tanker. But we cannot ignore the pressure from the US agrifood and industrial sectors to gain access to Canadian and Mexican waters (...).

In the Middle East, many works have been carried out on the two great rivers, the Tigris and the Euphrates, whether in Turkey, Syria or Iraq. A water war is taking place between states for control of this resource.

The following two maps give an overview of the current problem regarding water resources. Other data concerning irrigation and potential conflict areas can be compared.

Water: weapon and military target

The history of humanity is dotted with examples, from all regions of the world, illustrating the use of water as an instrument or target during conflicts. We will name just a few:

In 596 BC. AD, to put an end to an interminable siege, Nebuchadnezzar destroys part of the aqueduct which supplies the city of Tyr.

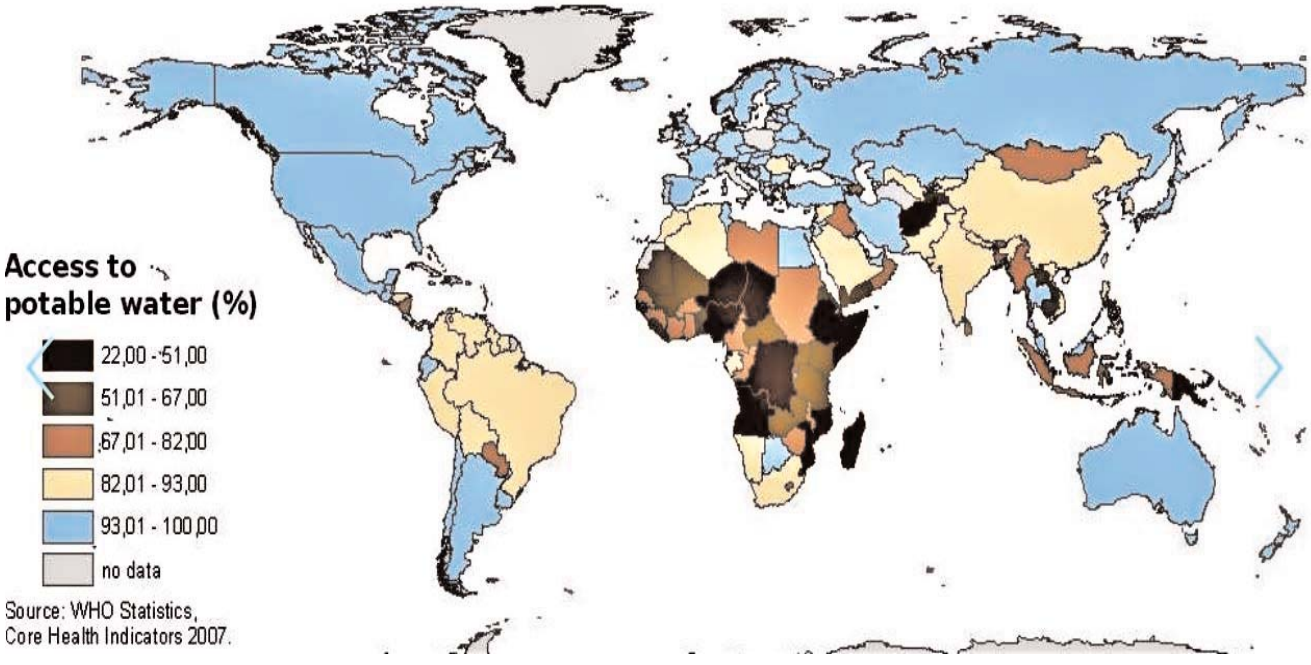
In 1503, during the struggle waged by Florence against Pisa, Leonardo da Vinci and Machiavelli aspired to divert the course of the Arno, to cut off Pisa from its access to the sea. In 1938, in order to flood the areas threatened by the Japanese army, Chiang Kai-shek ordered the destruction of the dykes on part of the Yellow River in China. In 1939-1945, the power station dams, considered strategic targets, were bombed.

In Vietnam (1960s), many dykes were destroyed by bombing. Between 2 and 3 million people are believed to have drowned or starved to death as a result of these attacks.

In 1999, in Kosovo, water points and wells were contaminated by the Serbs. The same year, a bomb explosion destroyed the main pipeline in Lusaka, Zambia, and deprived its 3 million inhabitants of water.

Since the end of the 20th century, resources and equipment have come under increasing threat, particularly in Africa, the Balkans and the Middle East.

Since November 2002, water has been recognized as one of the fundamental human rights. This is enshrined in the General Comment on the Right to Water, adopted by the Covenant on Economic and Cultural Rights (CESCR), itself ratified by 145 countries.

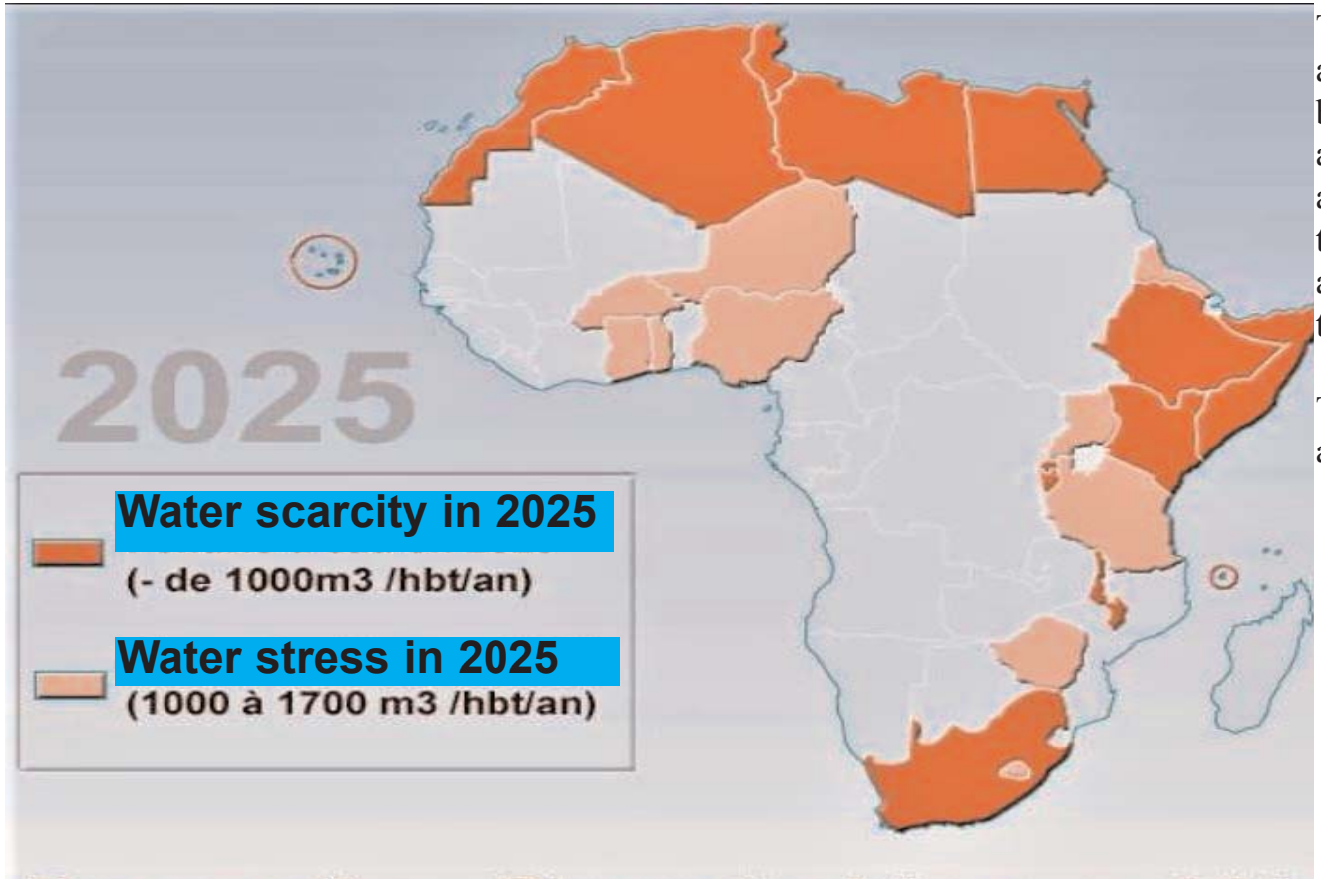


It has since been prohibited, "for whatever reason", to attack, destroy, remove "property essential to the survival" of the civilian population, such as "drinking water installations and reserves and works of irrigation".

It is forbidden to attack "works of art or installations containing dangerous forces, namely dams, dykes and nuclear power plants for the production of electrical energy".

To what extent can these provisions be applied?

Many obstacles prevent the application of these provisions:



The 1977 Protocols have not been ratified by all Member States. Protocol I has been ratified by 159 states, but unanimity has not been achieved and politically strong countries such as the United States have opposed its ratification. New forms of conflict (such as terrorism and internal conflicts) do not fall under international humanitarian law.

There is no international institution effectively able to apply these provisions.

Water, sanitation, hygiene: an essential factor of well-being

Already, in 2009, the director of the Potsdam Institute on the effects of climate change, Johan Rockström, identified nine limit thresholds which could not be exceeded without endangering humanity (A safe operating place for humanity, 2009). However, four of these planetary limits have now been crossed: climate, biosphere, biodiversity and nutrients. Two are on the eve of being so: fresh water and ocean acidification.

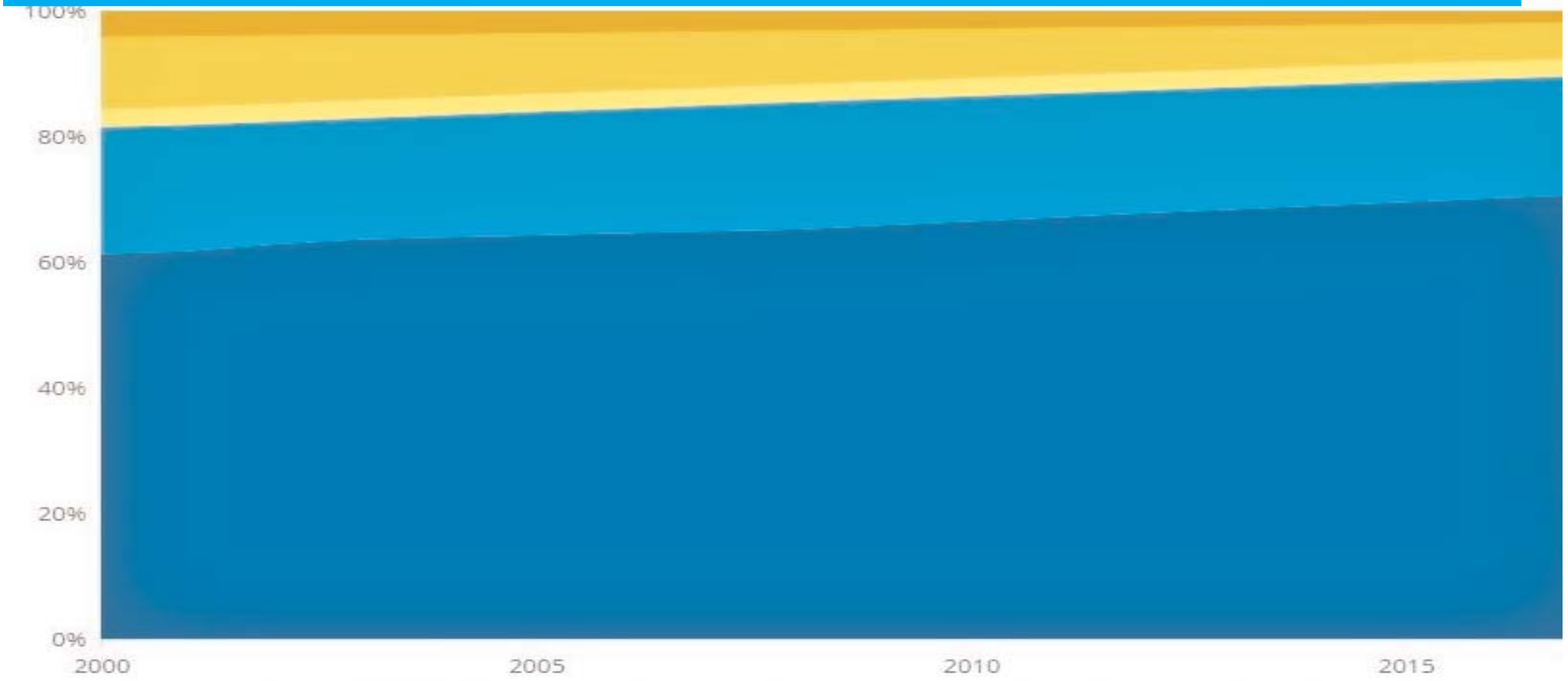
PURE WATER

Water touches all aspects of development and is linked to almost all of the Sustainable Development Goals (SDGs). It drives economic growth, supports healthy ecosystems, and is essential and fundamental to life itself.

Climate change is expressed through water. 9 out of 10 natural disasters are water-related. Water-related climate risks affect food, energy, urban and environmental systems. If we are to achieve climate and development goals, water must be at the heart of adaptation strategies.

Access to drinking water and sanitation is a basic human right. Ensure universal, adequate and equitable access to safely managed

Access to drinking water by level (% of world population)



Sources : Programme commun OMS/UNICEF pour le suivi de l'approvisionnement en eau, de l'assainissement et de l'hygiène ; Indicateurs du dé
monde (SH.H2O.SMDW.ZS ; SH.H2O.BASW.ZS).

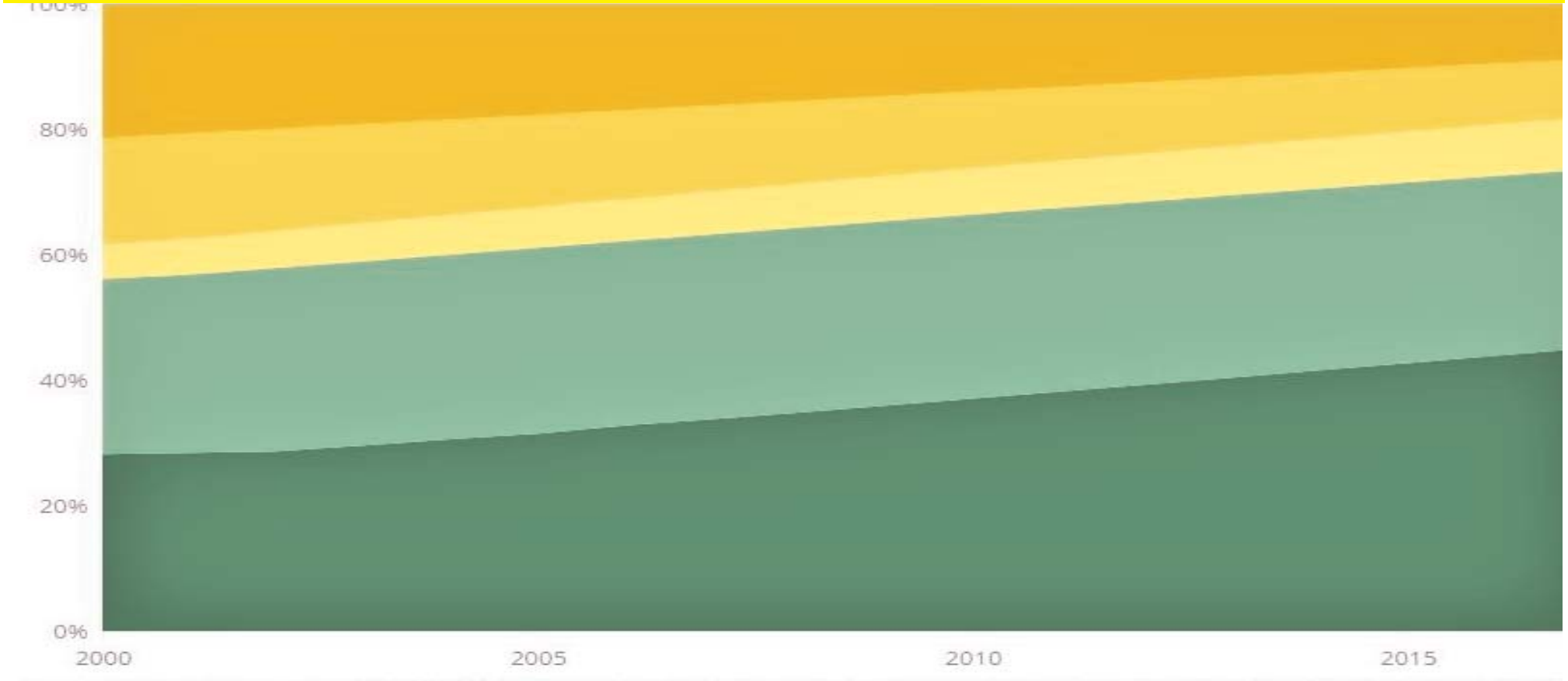
water and sanitation services is at the heart of sustainable development. The importance of good hygiene through hand washing and the availability of clean water has been highlighted by the COVID-19 pandemic. Despite the progress made in recent decades, several billion people around the world still do not have access to water and sanitation, with only ten years left to achieve the SDGs.
Some 2.2 billion people worldwide lack safely managed drinking water services, 4.2 billion people lack safely managed sanitation services and 3 billion lack basic facilities for washing hands.

Water and sanitation: an essential ingredient for health, the environment and sustainable development. The various conditions of access to water in the world are classified according to a scale of five levels. basic sanitation.

These people can sometimes access an improved installation, but shared with other households (limited sanitation service) or use an unimproved installation. Others have no facilities and are forced to practice defecation in the open air, in fields or woods for example.

More than half of the world's population remains without safe sanitation facilities

Access to sanitation by level (% of world population)



Household income is an important determinant, with the poorest generally having less access to sanitation services. In many countries, the poorest households have less access to sanitation services.

The possibility of benefiting from at least basic sanitation services varies greatly between countries. While some, such as Kazakhstan, North Macedonia and Thailand, have near universal access, in several sub-Saharan African countries such as Ethiopia the average rate is below 20%.

In addition, access differs significantly across income groups within countries. In Namibia, 87% of the population belonging to the richest 20% of households have access to at least basic sanitation, compared to only 4% among the poorest 20% of households.

Hand washing: an essential gesture to improve hygiene...
Hand hygiene has been at the heart of campaigns to control the spread of COVID-19. Handwashing with soap and water is one of the most effective ways to prevent the transmission of many other infectious diseases as well. According to the United Nations Children's Fund, this action reduces the risk of diarrheal disease in children by 40%.

As with water and sanitation, there are large differences in access to handwashing facilities across income levels.

Some countries in South Asia also have low access rates: less than 40% of people in Bangladesh and Afghanistan have basic handwashing facilities at home.

They are 48% in Nepal and 60% in India. The situation is particularly critical in rural areas. In Afghanistan, for example, 64% of the urban population has handwashing facilities, compared to 2% of the rural population.

Critical services away from home
It is essential that water, sanitation and hygiene services are also available outside the home, in places such as health and education establishments for example. A significant number of health facilities lack basic hand hygiene facilities

Over the past twenty years, access to water, sanitation and hygiene services has steadily improved in many parts of the world. Nevertheless, inequalities of access persist in some low- and middle-income countries. Rural dwellers and poorer households are more likely to be disadvantaged in access to water and sanitation services.

Access to safely managed water and sanitation services is a crucial element of sustainable development, but many countries still lack the data needed to measure progress. In 2017, about half of countries lacked data on access to safely managed water services and this proportion was close to 60% for access to sanitation services.

"Green water" in the red zone

Why this sudden "tilt" into the red zone? Because the researchers have, for the first time, worked on what they call "green water". The concept was developed by researchers at the Stockholm International Water Institute (Siwi, Sweden). While "blue water" corresponds to that resulting from precipitation and that human activities take from natural reservoirs, the concept of "green water" enriches it with evaporation and soil moisture. . In other words, water available to plants.

Water is the blood of the biosphere. But our activities profoundly modify its cycle. The work carried out by the researchers shows that the disturbances in the freshwater cycle are today such that there is a real risk of ecosystem collapse.

PERSPECTIVES

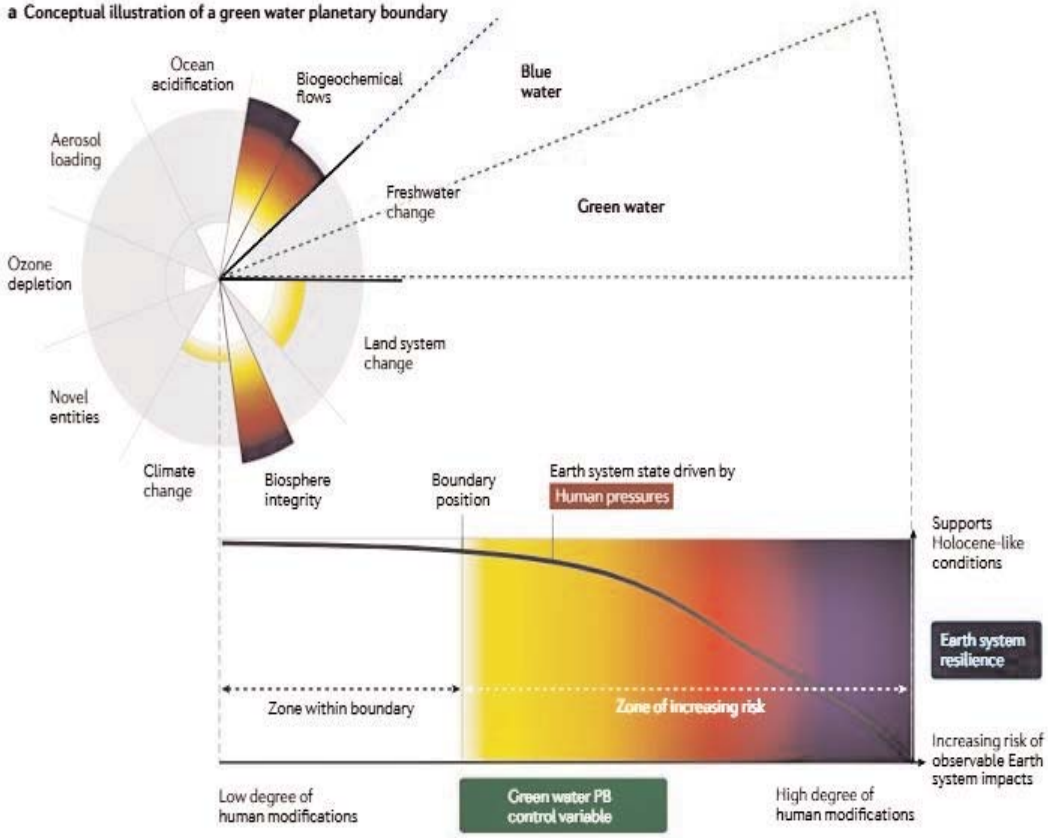


Fig. 1 | **The conceptual framework of a green water planetary boundary. a** | The planetary boundaries framework with its nine boundaries, including the proposed renaming of 'Freshwater use' as 'Freshwater change', subdivided into a blue and a green water sub-boundary. The lower panel illustrates the relationship between the degree of human modification of the green water planetary boundary (PB) control variable and Earth system resilience implications. **b** | The key relationships (thick grey arrows) considered in selecting a suitable green water PB control variable. Adding a new green water component to the planetary boundaries framework requires defining a quantifiable control variable that can signal rising Earth system risks caused by anthropogenic green water modifications. Top left illustration in panel **a** is adapted, with permission, from REF.[2], AAAS.

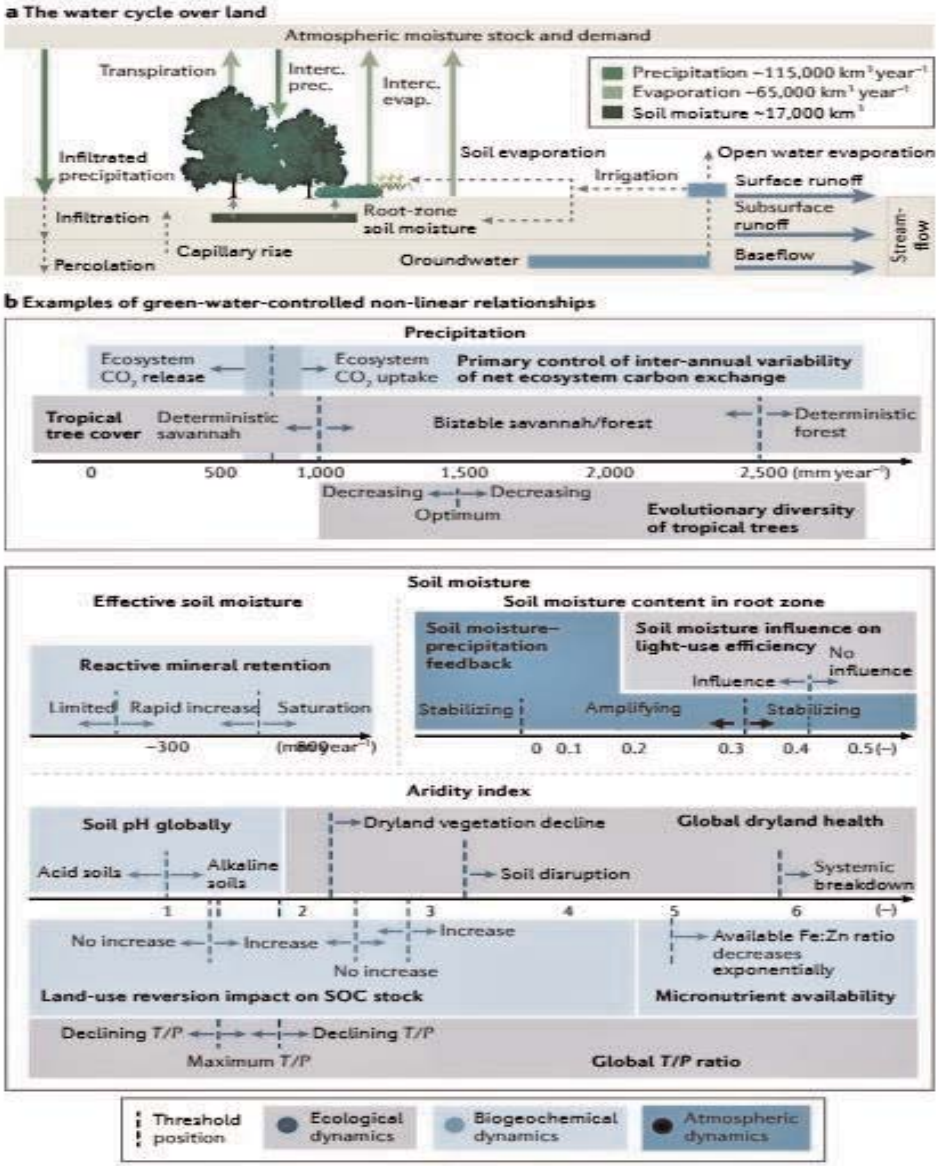


Fig. 2 | **Green water and associated non-linear relationships. a** | Overview of the water cycle over land, including estimates[9] of global land precipitation[210], evaporation[108] and soil moisture[190]. Green arrows and boxes indicate green-water flows and stocks, respectively. Blue arrows indicate the flows accounted for in the current blue-water-based 'Freshwater use' planetary boundary. Dashed grey arrows indicate other considerable hydrological flows that indirectly affect the green and blue water flows and stocks. **b** | Non-exhaustive overview of precipitation (*P*, top) and soil-moisture (bottom)-controlled non-linear relationships: effective soil moisture is defined as precipitation minus potential evaporation (E_{pot}) and the aridity index as E_{pot}/P. The *x* axes indicate the value of a specific green water planetary boundary control variable, with vertical dashed lines representing thresholds for ecological, biogeochemical or atmospheric responses (different blue shading); the threshold is broadly used to refer to a point or small range of values, on either side of which the relationship between the control and response variable considerably differs in character. Green water changes across a wide range of wetness can generate non-linear ecological, biogeochemical and atmospheric change. Interc., interception; SOC, soil organic carbon; *T*, transpiration.

The survival of the Amazon rainforest, for example, is highly dependent on soil moisture. In addition to deforestation, a drop in this humidity -- due to global warming -- now directly threatens entire regions of this precious green expanse. There is reason to fear that the Amazon will reach a point of no return... and turn into savannah!

"These processes can be very difficult to stop once they have started. It is of the utmost importance that we reverse this trend," conclude the researchers. Especially since the problem does not stop at the Amazon rainforest. It affects the whole planet. Soil moisture now changes from boreal forests to tropics to farmland to temperate forests.

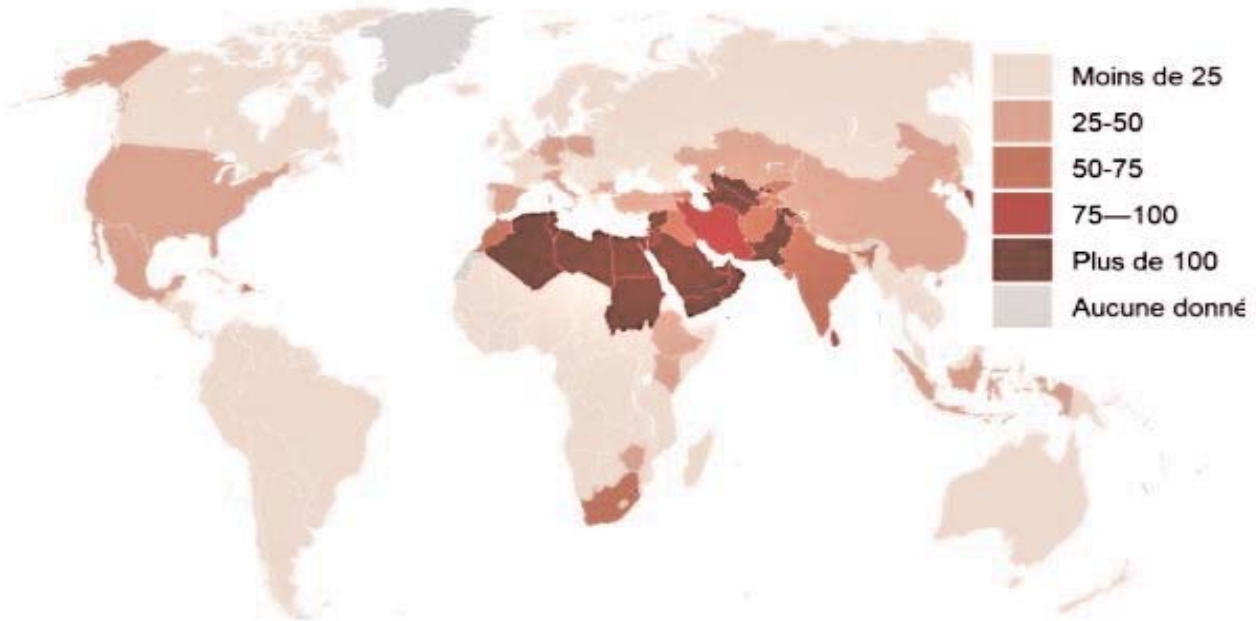
The researchers also note that these chemicals can also affect other planetary boundaries. When fossil fuels are used to produce them or microplastics pollute freshwater supplies, for example. And while scientists believe the rate at which these products are appearing now far exceeds the ability of governments to both assess risks and control potential problems, they call for "a cap on production and release of chemicals".

Expanding the supply and availability of water where and when needed is vital. This includes investments in water storage, water reuse and recycling and, where appropriate, desalination. These interventions should be accompanied by policies to promote water efficiency and improve water allocation. Economic growth is "thirsty business". Water is a vital factor of production, so diminished water supply results in slower growth. Some regions could see their growth rates decline by up to 6% of GDP by 2050 due to water-related losses in agriculture, health, income and prosperity. Ensuring an adequate and constant supply of water in a context of growing scarcity is essential to achieving global poverty reduction goals.

Water proofing savings to limit the impact of extremes and uncertainties are also priorities. Better urban planning, expansion of crop insurance to protect farmers, and citizen engagement will build resilience and minimize the economic impacts of adverse events.

Water stress in the Middle East and Africa

Freshwater withdrawal in 2009 - 2017 in %



Source : FAO. Base de données des ODD de l'ONU (ER_H2O_STRESS)

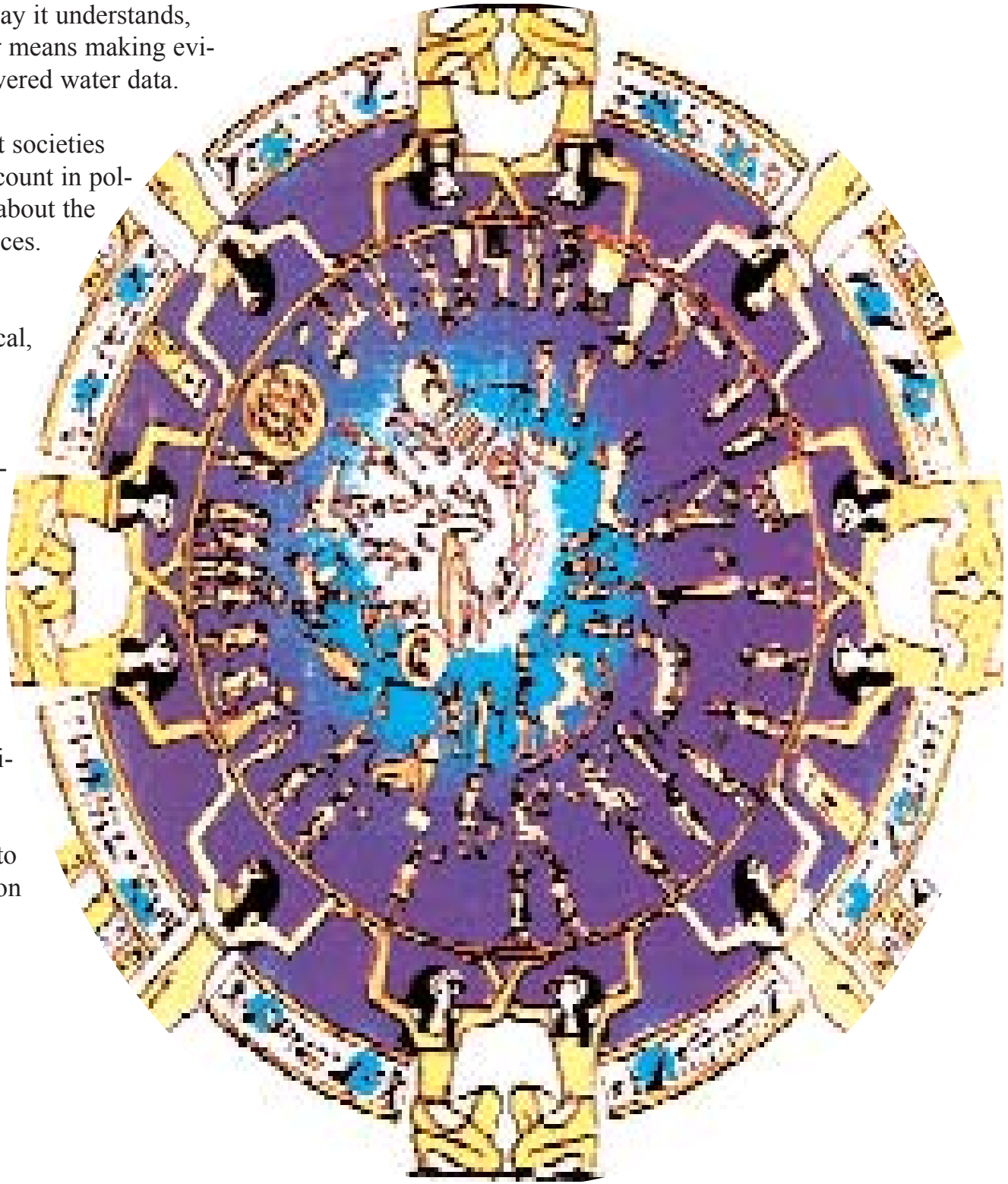
The world needs a fundamental change in the way it understands, values and manages water. Understanding water means making evidence-based decisions about water using empowered water data.

Valuing water means recognizing the values that societies place on water and its uses, taking them into account in policy and business decisions, including decisions about the appropriate pricing of water and sanitation services.

Managing water means pursuing integrated approaches to water resource management at local, national and regional levels.

Sanitation is essential for health, economic growth and the environment. Investing in sanitation is about preventing unnecessary deaths, investing in people and transforming lives. 297,000 children under 5 die from diarrhea related to insufficient WASH. Poor sanitation and contaminated water are also linked to the transmission of diseases such as cholera, dysentery, hepatitis A and typhoid.

Political commitment and leadership, technological innovations and breakthroughs in service delivery and financing models are all needed to help governments deliver on their commitment to ensure access to adequate and equitable sanitation and hygiene for all by 2030.



FOOD

Cereals

The eastern territories of Turkey saw the birth of the first domesticated crops of wheat and barley in the world, including " kavilca ". This cereal, known in French as "emminnier", has survived millennia by passing from the hands of one generation to those of another. Its days are now numbered, along with those of a dozen other rare foods.

Today, only a few emmer cultures remain. The cereal is among the endangered foods featured in the book Eating to Extinction: The World's Rarest Foods and Why We Need to Save Them .

Its author, BBC journalist Dan Saladino , has traveled the planet to bear witness to this collapsing diversity, weakening the food system and influencing the taste of dishes around the world. We spoke to him.

From restaurants to supermarkets, the amount and variety of food seems endless. Everything seems to be offered in abundance! On the other hand, it is an industrialized and transformed version of the real diversity. Uniformity guides the choices made by the food industry to the point of pushing plant and animal species towards extinction.

Take the example of bread and its main ingredient, wheat. The genetics of this cereal are reduced to the extreme at the moment. Yet the wheat genome is of considerable size and complexity. Today, farmers choose cultivated grain varieties from a recommended list of only about 20 options.

There is a wonderful place in the Arctic, 1300 km from the North Pole, called Svalbard. A vault (New window) was dug there in the heart of a frozen mountain to preserve more than 200,000 varieties of wheat from extinction. The World Seed Vault in Norway proves the limitless potential of cereals. This genetics responsible for the flavors and characteristics of the plant plays a crucial role in protecting crops from diseases, pests and droughts. Yet in today's food system, variety remains extremely limited by comparison.

History is replete with events where monoculture (or lack of diversity) led to disastrous consequences. Take the example of the Great Famine in Ireland, where potato farming collapsed in 1845 due to an epidemic of late blight.

The same variety of potato, the Lumper , was planted repeatedly in the same soil until an outbreak of the parasitic disease ravaged the crops and plunged the country into famine. The low genetic variety of cultivated potatoes weakened its resistance to late blight, which caused a shortage of resources, leading to starvation and the death of over a million Irish men and women.

Now back to the 21st century. The Cavendish banana dominates world crops. But she is dying. Why ? Bananas are all clones of the same variety. Panama disease is taking these monocultures one after another all over the world. The time will come when it will be impossible to plant them again.

Lack of diversity affects the foods we love and depend on. That should worry everyone.

Saving a wild orange growing in this region could prove vital for citrus fruits elsewhere on the planet.

Meghalaya (India) is a biodiversity hotspot. Much of the food eaten today has its origins there. The memang narang is one of them. This highly prized wild orange has a distinctive bitterness. The plant contains a natural chemical compound that protects it from diseases and unwanted species. So it is this immune function of the memang narang which gives it this bitter taste and its medicinal properties.

Over thousands of years of production, the creation of larger, sweeter fruits has resulted in the loss of the citrus fruit's natural defense mechanism, and thus the loss of its unique taste and characteristics. It then became necessary to spray her with chemicals to protect her.

The Garo people value the sour taste of memang narang and its ancestral origins. Bitterness disappears from our western palettes. The fruits become increasingly sweet, at the expense of their survival.

Does the survival of the human species depend on food diversity?
Sure. At a time when food systems are weakened by climate change, it is our duty to produce food in harmony with nature.

In Tanzania, the Hadza live by hunting and gathering. The diet of this East African people is based on a menu of 800 species of plants and animals. Archaeologists have studied the lifestyle of this population and its history, which spans thousands of years.

The hunter-gatherer lifestyle remains the most successful in terms of survival in all of human history. I do not propose to go back there, but to draw inspiration from this approach to biodiversity.

Scientists have discovered in the stomachs of preserved Hadza bodies more than 50 types of seeds and bacterial patterns that adapt to the seasons. Their intestinal bacterial population surpasses the variety of that of present-day Western populations. It should be a clue that proves to us that the human species survives thanks to diversity. Even today, the people of Tanzania live with the rhythms of the seasons and surround themselves with various wild species.

What should we remember from the history of the food system in relation to the human species?
For most of human history, our survival has been linked to that of flora and fauna. It was only recently that we introduced this idea that it is possible to disconnect from nature and even crush it.

The technological leap experienced during the green revolution from the 1940s to today is based on the control of nature. The agricultural sector believed it had discovered a solution to feed the entire planet with the use of chemicals and selective breeding. It's a reductionist approach, in my view. Nature is so much more complex than that!

When we look at this phenomenon through the lens of crop disease and the loss of diversity in the human diet, we quickly realize that this reductionist approach comes at a very high price.

Are you optimistic for the future?
Initiatives like in the region of Swabia, Germany, give me hope. On mountainous lands in the south of the country, generations have grown lentils alongside wheat and barley on difficult-to-practice soils.

The distinctive variety of the place is the alb-leisa . Swabia's favorite died in 1960. The industrialization of Germany pushed people out of the fields and into the factories. Across the ocean, Canada has become one of the largest lentil exporters in the world, pushing alb-leisa even further into oblivion. Why grow German lentils when Canadian lentils are cheaper?

German Woldemar Mammel never accepted his disappearance. According to him, the alb-leisa represents a key element of the food autonomy of the region and its way of life. In the early 90s, he made it his mission to plant this legume again in Swabia. But the seeds no longer existed. The farmer traveled as far as the Vavilov Institute , in St. Petersburg, Russia, which had one of the world's largest collections of plant genetic material.

Today, on the Swabian mountains, hundreds of alb-leisa crops grow thanks to the efforts of this man.

UN warns against overexploitation of wildlife

The overexploitation of wild species threatens the well-being of billions of human beings, warns the UN in a report on Friday, which gives avenues for their more sustainable use and highlights the knowledge of indigenous peoples.

Billions of people around the world, in both developed and developing countries, depend on and benefit from the use of wild species, say experts from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).

Around the world, around 50,000 wild species are exploited through different practices, such as fishing, gathering or logging, including more than 10,000 species harvested directly for food, according to The report.

In 2019, the IPBES revealed that one million species were threatened with extinction, mainly due to their exploitation by humans.

In this new report, 85 social and natural science experts and local and indigenous knowledge holders have reviewed 6,200 sources. Rich countries do not notice it, but wild plants are used in the composition of medicines or cosmetics, explains researcher Jean-Marc Fromentin, co-author of the report, to AFP.

"Wild species are a key issue for food security, [but] we will lose these resources if we overexploit them, with a direct impact on human populations.
- A quote from Jean -Marc Fromentin, co-author of the report
It is 70% of the poorest populations in the world who depend directly on these species , recalls for her part the researcher Marla Emery, who co-signs the report. In addition, 2.4 billion people need wood for cooking.

Wild species are also important sources of income and employment, the report points out. Before the COVID-19 pandemic, tourism in protected areas generated US$600 billion per year.

Overexploitation affects 34% of fish stocks, endangers 1,341 wild mammals and 12% of wild tree species, and seriously endangers sharks and rays.

Illegal wildlife trafficking is considered third in the world behind human and drug trafficking and is worth between 69 and 199 billion dollars per year.

Drawing inspiration from indigenous knowledge
However, solutions exist, according to experts. Despite everything, the report carries a message of hope, assures Jean-Marc Fromentin, attached to Ifremer (French research institute for the exploitation of the sea).

We can have a use of wild species that is sustainable and sustainable over time, for future generations, he insists.

Wildlife is best managed by indigenous peoples, who value nature there and incorporate it into their practices, according to the report's authors.

It often goes through fairly simple rules of reciprocity, respect for nature and animals and taboos, sacred areas which are equivalent to protected areas for us, explains Jean-Marc Fromentin.

The report proposes in particular to reduce illegal fishing, to remove harmful subsidies or to support more local fishing, to set up certifications for logging, to have effective governance systems and a fair redistribution of profits. and wildlife-related costs.

"The illusion that humanity could exist separately or in control of the rest of nature [...] has led to major environmental crises, such as climate change and the decline of biodiversity. "

Considering humanity as part of nature, that is, one member or citizen of nature among others, would establish the foundations for a more respectful and sustainable relationship, conclude the researchers, who refer following the example of Indigenous peoples and the need for transformative change.

This report, endorsed by the 139 member countries of the IPBES meeting in Bonn, Germany, makes it possible to show the state of knowledge [and] what the scientific community says, stated Hélène Soubelet , of the Foundation on research for biodiversity (FRB).

It appears a few days before another IPBES opus devoted to the values and evaluation of nature.

These two reports will feed into the discussions at the 15th Conference of the Parties (COP15) of the United Nations Convention on Biological Diversity, which will be held in December in Montreal. This summit should make it possible to set a regulatory framework in order to protect nature and its resources by 2050.

United Nations biodiversity experts warned in 2019 that more than three quarters of the land and 40% of the oceans on the planet have already been seriously degraded by humans.

But there are relatively few studies looking at specific species and how humans modify their behavior.

For this study, published in the journal Nature Ecology & Evolution(New window)(in English), Australian researchers studied the consequences of activities such as road construction, tourism, recreation, hunting, transport and fishing for 167 species, ranging from a 0.05 gram butterfly to a 2 ton great white shark.

And according to them, most species have increased the distance they travel by 70% on average because of humans. For a third, these movements have increased, or decreased, by half.

his tells us that humans have a large impact on animal movements, but that it usually goes unnoticed and nothing is done, lead author Tim Doherty, from the University of Sydney, told AFP.

However, many species, including most mammals, spend almost all their energy finding food and mating partners. The extra energy they need to get away from humans therefore complicates their survival, he explains.

Of the animals studied, birds and insects moved more to avoid contact with humans.

The study warns of cascading consequences on natural processes such as pollination if these shifts were to continue at a sustained rate, with potentially profound impacts on populations, species and ecosystem processes.

The researchers call for better preservation of natural habitats by increasing protected areas, but also for regulating construction and tourism, and limiting seasonal hunting during breeding periods.

Biodiversity: "It's a collective failure", concludes the UN

Ten years ago, 192 countries set ambitious goals for the decade 2011-2020 to preserve the planet's biodiversity. At the end of COP10 in 2010, which was held in Nagoya, Aichi Prefecture, Japan, the international community adopted the twenty Global Diversity Goals for 2020.

A decade later, when the deadline for the commitments has come to an end, the United Nations publishes the results of these promises in the 5th report of the Global Biodiversity Outlook. The results are not encouraging, as none of the twenty objectives has been fully achieved. Only six of the twenty goals are on a more positive track.

Trained as a biologist and specialist in plant ecology, Anne

Larigauderie was at the forefront of the Nagoya meeting in 2010. She is now the executive secretary of IPBES, the Intergovernmental Platform on Biodiversity and Ecosystem Services, the organization that is described as the IPCC for biodiversity.

Where does the data come from that allows you to take stock of a decade of action on biodiversity?

On the one hand, the report is largely based on the major global biodiversity assessment, published by IPBES last year, and on the reports that each government must provide to the Convention on Biological Diversity on how it has met the twenty objectives for 2020.

You say it's a collective failure. What would be a good example of what went wrong?

We had set ourselves the objective of significantly curbing the loss of natural habitats. However, we have moved away from this objective because deforestation continued to increase during this decade.

That is really a disappointment. Well, the recent rate of deforestation has fallen from that of the previous decade, but only by a third, and it may be accelerating again in some areas. But the destruction of forests and the fragmentation of natural habitats continue.

The other example is fishing: a third of fish stocks are still overexploited. These are two examples of failures, where one might have thought that we were going to reverse these trends.

Let's put nature at the heart of all their sectoral policies such as agriculture, energy, tourism, transport and finance! Without biodiversity, all other development goals cannot be achieved.

Saving seeds in the Arctic for future generations
In a few weeks, a batch of Canadian seeds will be heading to Svalbard, Norway, to be frozen there for eternity in the belly of a frozen mountain.

In the fields of Agriculture Canada, in Saskatoon, Axel Diedrichesen contemplates the wheat swaying in front of him. Exceptional wheat. "Some varieties are among the first wheats grown in the country," says the chief curator of the seed bank of Canada.

Part of the seeds of these wheats will soon find themselves frozen in the hollow of a mountain near the North Pole.

"The Svalbard Vault is our insurance policy. It stores a copy of all our national collections. It's our safe deposit box to protect our collections in the event of disasters here at the bank in Saskatoon," says Axel Diedrichesen .

The specialist then directs us to a corner of his warehouse, where he is preparing the next shipment for Svalbard.

The loot contains more than 3000 different seed envelopes. Double collections of vegetables, such as tomatoes or cucumbers, legumes, and of course, a multitude of cereal varieties.

Some of these varieties are recent. Others are varieties forgotten and shunned by modern agriculture. Some have even disappeared from the fields.

"Canada has the largest oat collection in the world," says the specialist. Some of these envelopes contain varieties that do not exist anywhere else in the world. "
Please note that this article published in 2017 may contain information that is no longer up to date.

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Seed is collected by two men at the Agriculture Canada Experimental Farm in Saskatoon.

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The Svalbard Fortress

The World Seed Vault on the island of Spitsbergen

The World Seed Vault is located on the island of Spitsbergen in the Arctic archipelago of Svalbard, Norway.

The objective of this vault is ambitious: to protect the most important cultures of the world in order to prevent their disappearance.

Built in 2008 in the permafrost of this island, the fortress should eventually house a copy of the collections of the 1,700 seed banks spread throughout the world.

It was designed to withstand the worst disasters: earthquakes, fires and terrorism. We have even anticipated the rise of the oceans due to global warming.

A 120 meter long tunnel, dug into the frozen rock, leads us to the heart of the mountain. Thousands of crates of seeds are stored there. Treasures from the four corners of the planet: sorghum, millet, wheat, potato, corn. There are more than 900,000 seed samples. The agricultural memory of the world is there, frozen before our eyes.

In a few steps, Mr. Von Bothmer takes us on a tour of the agricultural world. "Ecuador, Peru, Ukraine, Costa Rica, Nigeria; most countries on the planet have already entrusted us with part of their national collection," explains the specialist.

According to the Food and Agriculture Organization of the United Nations, the FAO, humanity has lost three quarters of agricultural biodiversity over the past century.

"Protecting the diversity of cultivated plants is essential. Every day, humanity loses varieties that are essential to its food security. "
- A quote from Roland Von Bothmer

Modern agriculture uses only about ten plants to provide most of humanity's vegetable protein needs.

This loss has serious consequences. In the face of climate change, agriculture is vulnerable. It needs diversity more than ever to counter disease and drought.

A bank criticized
Despite its laudable goals, Svalbard is subject to criticism. It is criticized in particular for financing itself in part from multinational agrochemicals such as DuPont Pioneer.

The annual report of the Global Crop Diversity Trust, the organization in charge of financing the Svalbard reserve, confirms the financial participation of these multinationals.

"95% of our funding comes from national governments that deposit seeds in Svalbard," says Marie Haga , director of this fund, valued at 251 million Canadian dollars.

Even minimal financial participation by these biotechnology giants opens the door to speculation. Some claim that this is a first step towards a seizure of these multinationals on these treasures of humanity.

Marie Haga refutes these allegations. "Seeds entering Svalbard remain the property of the receiving countries," she says. We only exist to find funds to secure the most important cultures of humanity".

A seed graveyard?
But are seed banks the only solution to the loss of cultivated diversity?

Scientist Pierre-Henri Gouyon , a professor at the National Museum of Natural History in Paris believes that gene banks like Svalbard are not a sustainable solution.

"Efforts to protect biodiversity must first and foremost be done with farmers," he says. Seed banks should not be used as an alibi for doing nothing in the fields. The researcher adds that by removing a seed from the field, the plant is prevented from Curator Axel Dieddrichessen is aware of the limits of gene banks. Keeping seeds in the fields will always be the best solution, he says. But in the face of industrial agriculture which unrolls its fields of monocultures, he believes that banks are essential.

"We no longer have a choice. It is better to save what remains of seeds than to lose varieties forever. "
- A quote from Axel Dieddrichssen

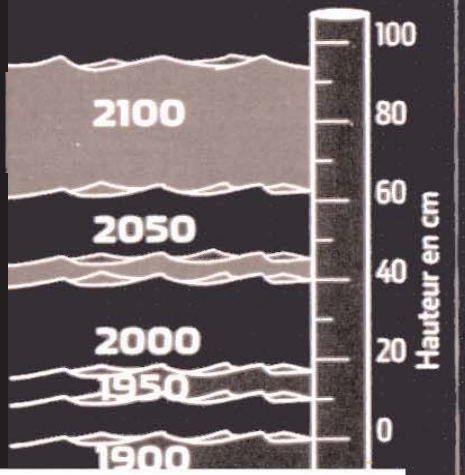
For his part, the botanist Roland Von Bothmer , who watches over the bank of Svalbard, reminds us that the two strategies are complementary. "We need to conserve more biodiversity in the fields, but we also need seed banks more than ever. "

The Swedish specialist continues by showing a crate: "Who knows, there may be a variety of wheat in this box whose genes will resist drought better in the future. With climate change, it is imperative to preserve this biodiversity," he concludes.

OCEANS

Sea level rise is accelerating

The increase in the temperature of the surface of the oceans, as well as the melting of glaciers and the polar ice caps should lead to a rise in sea level of several tens of meters.



The increase in the CO2 content of the air will be accompanied by an acidification of the seas… which will cause the dissolution of the shells of certain marine organisms (crustacean , coral)

More acidic oceans

GLACIERS

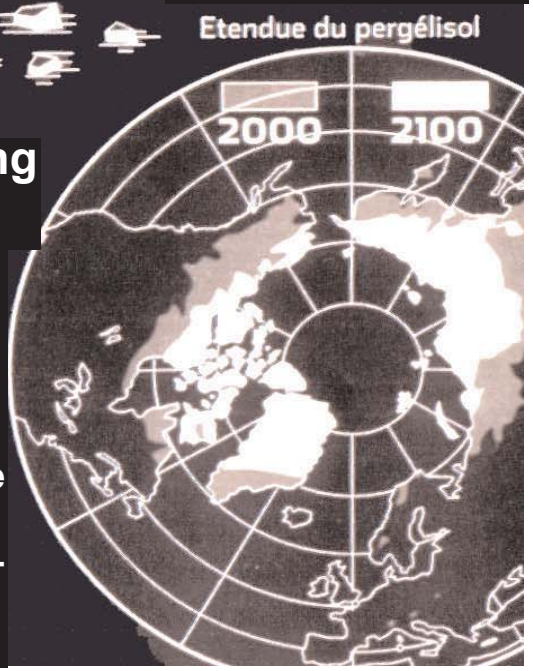
There will be no more pack ice during the summer

The Arctic Ocean could be sea ice-free in September around 2050

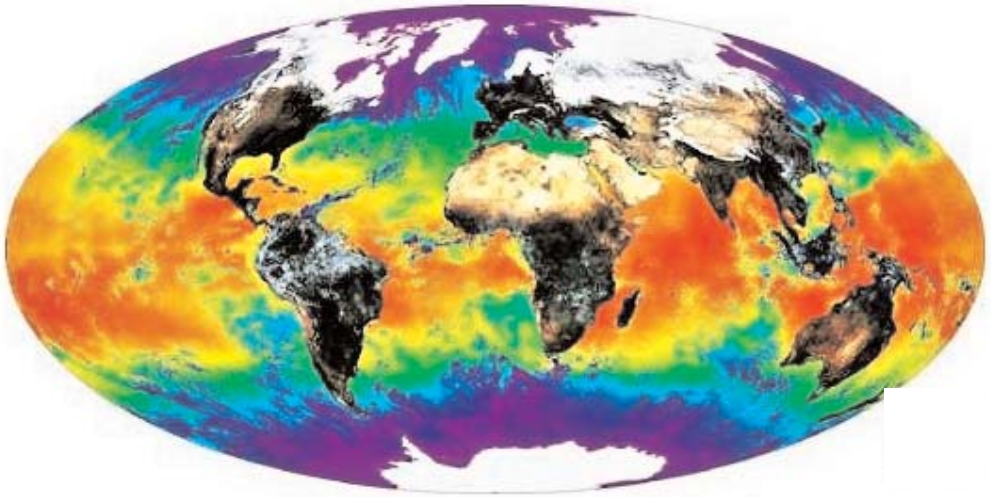
It is the percentage of small mountain glaciers - area less than 5 km2 - which will have disappeared in the world by 2100. This could be in Europe, 90% of alpine glaciers.

Permafrost is receding everywhere

More than half of the surface of the permafrost could have thawed by 2100. This would induce the release of large quantities of carbon and methane into the atmosphere which will further accelerate global warming.



ENERGY EXCHANGE OF OCEAN-ATMOSPHERE SYSTEM



Global view of surface temperatures

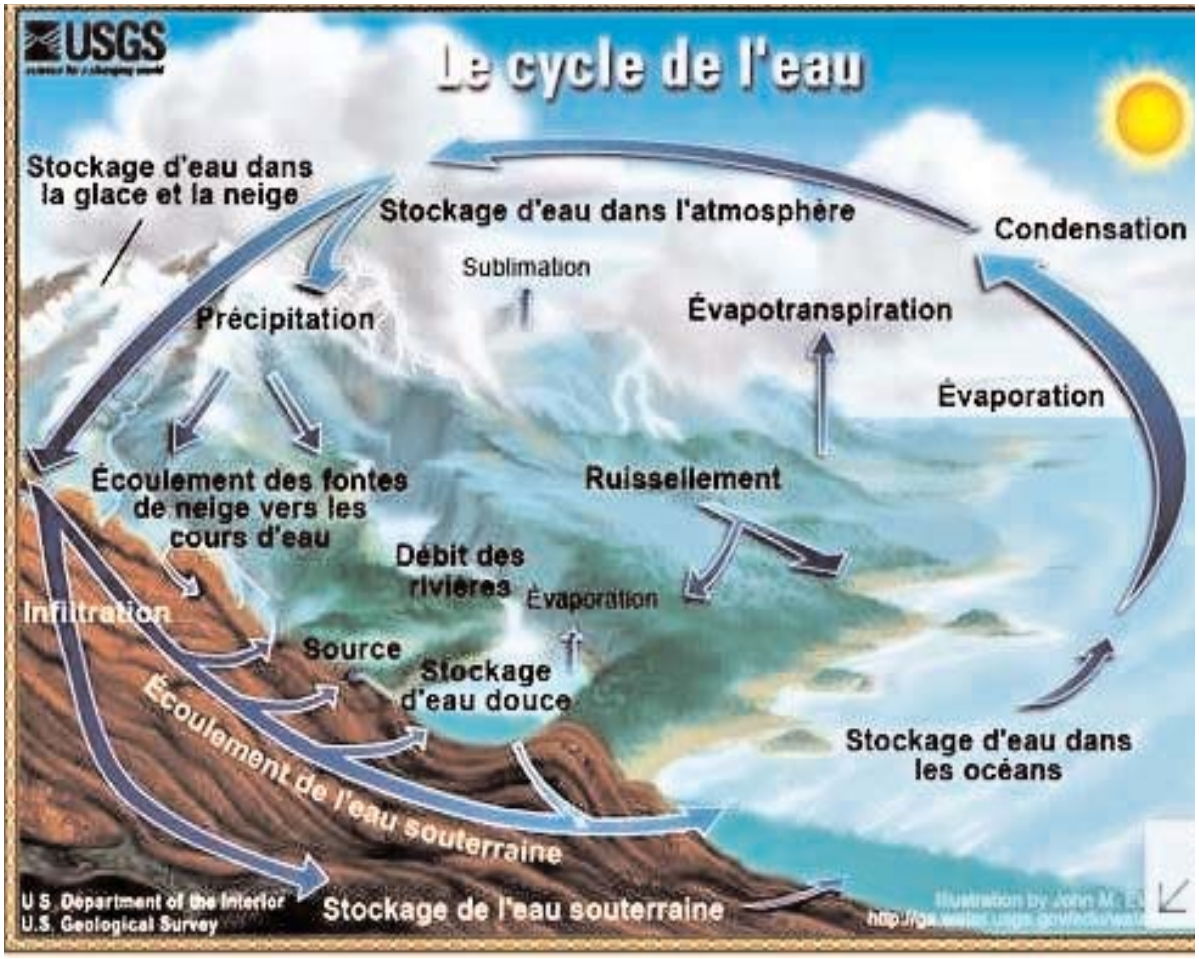
The ocean covers approximately 70% of the earth's surface. The surface of the sea is the place of transmission of energy and matter from the ocean to the atmosphere, and from the external environment (atmosphere, space) to the ocean.

Understanding the mechanisms of these exchanges, quantifying them with precision and monitoring their evolution, is therefore an important issue for understanding the climate and its processes, then for mastering the modeling of the coupled ocean-atmosphere system, and therefore of the terrestrial climate (surfaces however, are no less important).

The ocean surface is the main source of atmospheric water. However, water vapor is the main greenhouse gas, and clouds contribute to the water cycle, partially stopping solar radiation (right diagram).

The role of the ocean is not only to be a source of water, but also of heat: indeed, the thermal inertia of water is much higher than that of air or soil, which significantly slows seasonal cooling. In addition, marine currents such as the Gulf Stream or the Kuro Shio slow down winter temperature cooling, and soften contrasts with latitude (temperate climate up to 50° latitude N on the western edges of continents).

The ocean has a beneficial and protective role for nearby continental regions, but storms, cyclones and other violent weather events would be very rare without the oceans (source of heat and water, and no relief to prevent the wind from blowing !).
Finally, the ocean has been in the history of the earth at the origin of life, and aquatic life depends for its development on phytoplankton,

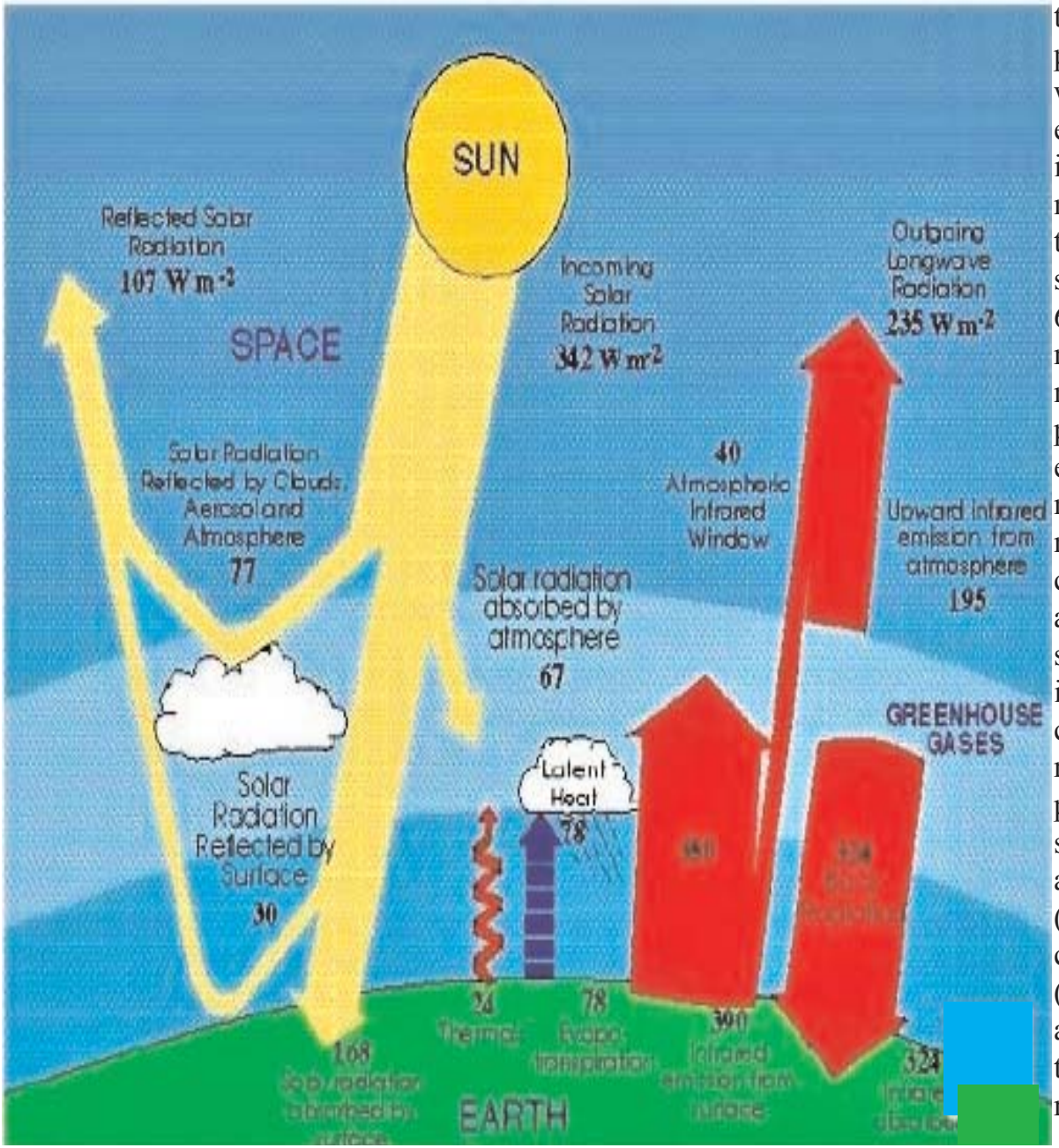


made up of microscopic algae. Phytoplankton grow near the surface, where sunlight reaches. Its presence allows the absorption (or emission) of carbon dioxide depending on the physical conditions of the interface (wind, pressure), and of course the nutrients available for primary production (phytoplankton growth).

These few examples show that for all areas of climate (seasonal forecasting, climate scenarios) but also for meteorology, hazard prevention, marine ecosystems and marine resources, knowledge of the mechanisms acting at the ocean-atmosphere interface is essential.

The main source of energy for the earth is the sun. This emits radiation centered in the visible range, which partially passes through the atmosphere before touching the surface. The surface reflects some of this radiation (depending on its albedo), and absorbs the rest. The penetration of light can reach several tens of meters into the ocean, allowing the upper layers of the sea to be heated, while only the surface of the ground is heated by the sun, this heat then penetrating by conduction.

The physical laws on the absorption of radiation express the fact that any body in thermodynamic equilibrium which absorbs radiation re-emits the same quantity. But this re-emission takes place at a wavelength which increases the lower the physical temperature of the body. This is why the emission from the earth is in the thermal infrared band of 10 - 12 micrometers (temperature of the order of 290K), while the sun, at a temperature of 6000K, emits in the visible range (between 0.4 and 0.9 micrometers). The atmosphere is not totally transparent to solar radiation: the molecules of the gases that make up the atmosphere, the cloudy droplets and crystals, and the dust (aerosols) have significant absorption powers in the infrared (gas and clouds) , dissemination and reflection. Thus the atmosphere is itself heated by the sun, and it in turn emits radiation in the thermal infrared (downwards and upwards); clouds reflect upwards (space) part of the radiation, absorb, re-emit and scatter the rest in all directions. The radiation balance of the



lower atmosphere takes all of this radiation into account. For example, on a clear, dry night, the atmosphere contributes very little to warming the surface of the earth, which thereby cools radiatively .

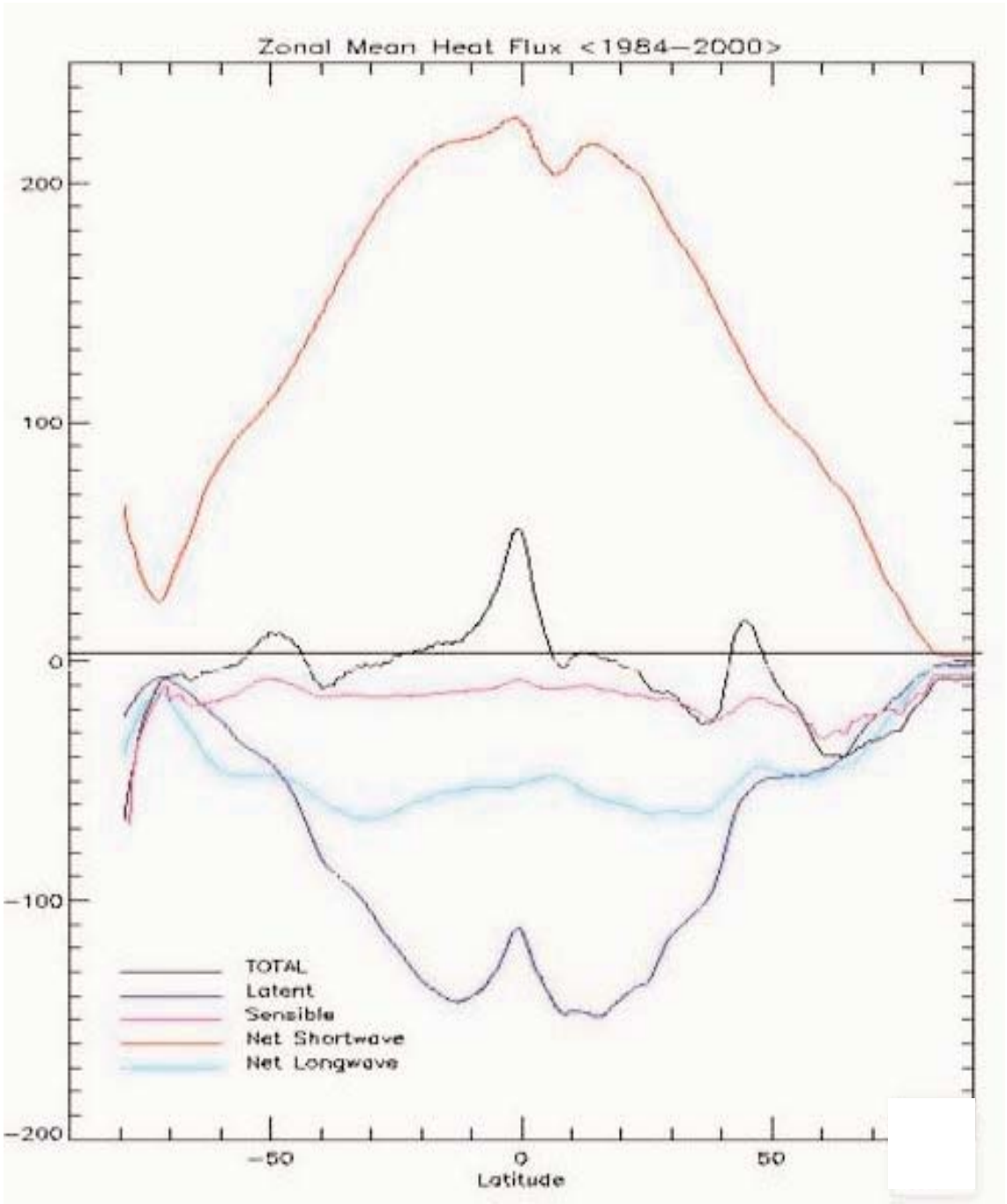
Conversely, the presence of water vapor and carbon dioxide, greenhouse gases, i.e. which absorb a large part of radiation and re-emit it, contribute to the warming of the lower atmosphere and the surface, as well as the cloud layer.

But to these radiative fluxes are added two other important fluxes at the surface: the fluxes of sensible heat and latent heat. When the temperature of the surface is higher than that of the atmosphere which overcomes it, the excess heat is transferred upwards by conduction and especially by turbulence, and this transfer is all the stronger as the difference temperature is high and the wind is blowing hard. Similarly, evaporation at the surface increases with the difference in humidity between the surface and the first layer of the atmosphere, and increases with the wind.

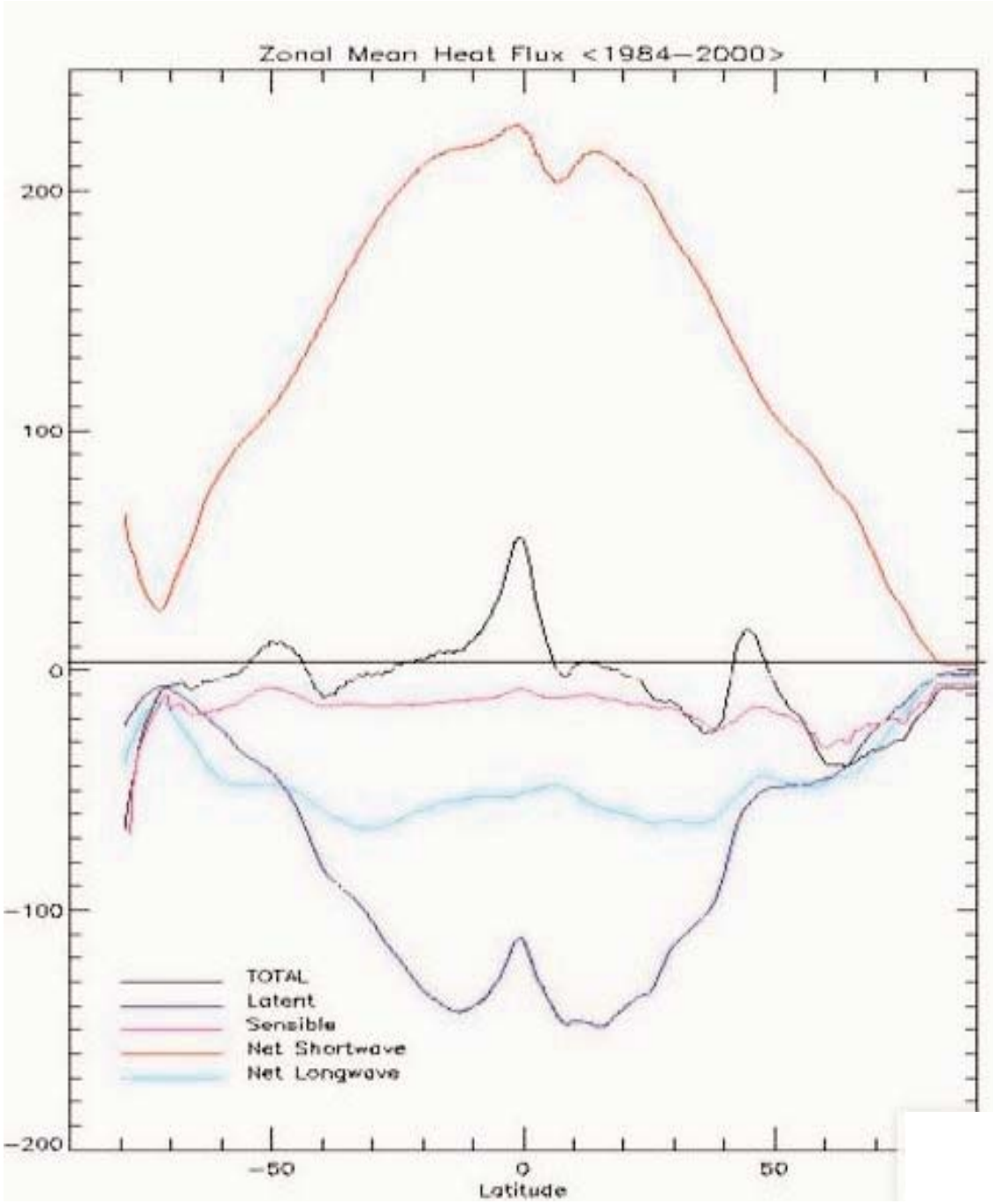
The evaporation results locally in a cooling of the surface, but the water vapour, by condensing higher in the atmosphere, restores the latent heat to the atmosphere. It is therefore a heat flux from the surface to the atmosphere.

In the case of the ocean, the surface energy balance (sum of the fluxes towards the atmosphere and towards the ocean, expressed in Wm-2) has the following characteristics:

1 - Energy lost by the ocean:
radiation (depending on its surface temperature): it affects a film of the order of a micrometer!
sensible and latent heat . Surface cooling by water evaporation is the main energy loss from the ocean



Radiation from the atmosphere (thermal infrared).
The figure above shows the average surface energy balance as a function of latitude. The net flux (solar = shortwave , infra-red= longwave) is the difference between flux entering the ocean and flux emitted.



Radiation from the atmosphere (thermal infrared).
The figure above shows the average surface energy balance as a function of latitude. The net flux (solar = shortwave , infra-red= longwave) is the difference between flux entering the ocean and flux emitted.

2 - Sources of energy for the ocean:
sun (mostly visible part of the spectrum), but the albedo of the ocean is low (about 0.08, while that of ice or snow can be as high as 0.9), so a significant fraction of solar radiation penetrates the sea.

This energy balance does not take into account mechanical energy sources for the ocean. Indeed, unlike continental surfaces, the ocean is a fluid which reacts, like the atmosphere, to the forces acting on it. Those are :

* the rotation of the earth (Coriolis force) and the earth's gravity, which induce currents and vertical movements. They contribute to distributing the heat received at the surface (mainly around the equator) towards the high latitudes, and to causing the colder and denser water to plunge into the depths in certain regions of the temperate and polar latitudes.

* the wind, which by friction on the surface, causes waves, swell, surface current. The wind also intervenes in the cooling of the surface by a mechanism of vertical mixing, between the water heated by the sun in the "mixed layer", which occupies the first tens of meters (even hundreds of meters in certain winter situations) and water located below the thermocline, transition zone located at the base of the mixed layer.

So far, we have only mentioned the energy exchanges between the ocean and the atmosphere. But the interactions between the two media also include exchanges of matter (gas, particles):

The sources of matter for the ocean are of course water (precipitation), but also atmospheric gases, which are either dissolved in the water (depending on the temperature, the

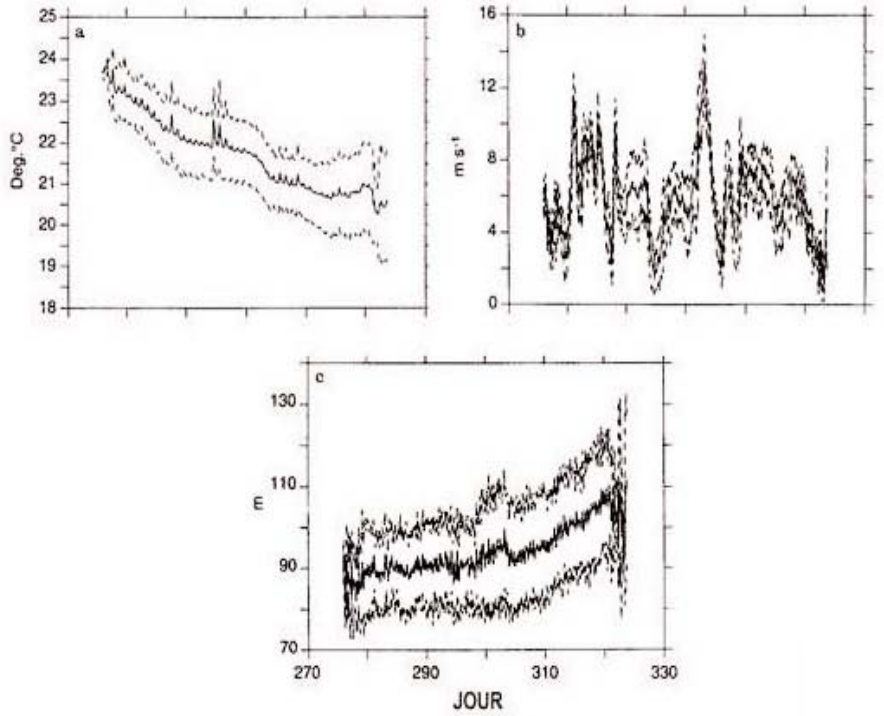
atmospheric pressure, the chemical composition of the water), or absorbed by biological processes (CO2), and finally particles (atmospheric, mineral or organic dust)

The ocean, in turn, provides the atmosphere with:
* water, of course, by evaporation
* CO2 (and other gases), depending on the wind and the partial pressure difference between the two media
* particles (salt, DMS - in fact "coagulation" into particles from gases (sulphur compounds) emitted by the surface)

These exchanges of different natures are not totally independent, because surface temperature and wind play an important role in the variations of most fluxes. Primary production (phytoplanction growth , associated with CO2 absorption) in turn has an effect on heat exchanges, as it modifies the turbidity of the surface water, hence the penetration of sunlight into the mixed layer.

In the following, we will focus on the exchanges of energy and water. It should be noted that the sensible and latent heat fluxes and the momentum flux (friction at the surface between the atmosphere and the ocean) are expressed as the statistical correlations between the small-scale fluctuations of the variables considered (vertical wind speed and temperature, humidity or horizontal wind). They are therefore called turbulent flows.

1 - Temporal characteristics:
Variations in ocean-atmosphere interactions are noticeable on time scales ranging from days to years, but inter-annual variations can be significant (with for example phenomena such as El Niño, which we will discuss later). The seasonal cycle dominates the variations of insolation but the fluctuations of shorter scale of the atmospheric circulation generate wide variations of the fluxes of heat, and of the mechanical forcing by friction of the surface:
* solar radiation is zero at night and varies by latitude with the season. The diurnal cycle has a small impact on ocean surface temperature.
* the cooling of the surface is mainly caused by gales, which mix the surface water and the deeper water. The cooling therefore takes place in fits and starts (in a few hours) from autumn, accelerating the cooling due to the reduction in solar radiation. Atmospheric flow passes over the oceanic regions of different temperature, the temper-



Exemple d'effet du vent sur la température de surface et l'épaississement de la couche mélangée sur une période de 45 jours (expérience SEMAPHORE, octobre – novembre 1993) : la température de surface, le vent, et la profondeur de la couche mélangée ont été mesurés par une vingtaine de bouées dérivantes dans un domaine de 500 sur 500 km2, et représentés ici par leur moyenne (trai gras) et l'écart type des variations (traits pointillés). On observe que la succession des coups de vent, et en particulier aux alentours du jour 303, provoque un refroidissement marqué dans les heures qui suivent, et un approfondissement progressif de la thermocline

ature of the lower atmosphere adapts almost instantaneously (but there can be modifications due to energy transfers, such as the appearance of clouds, deviation of the wind)

2 - Horizontal characteristics:

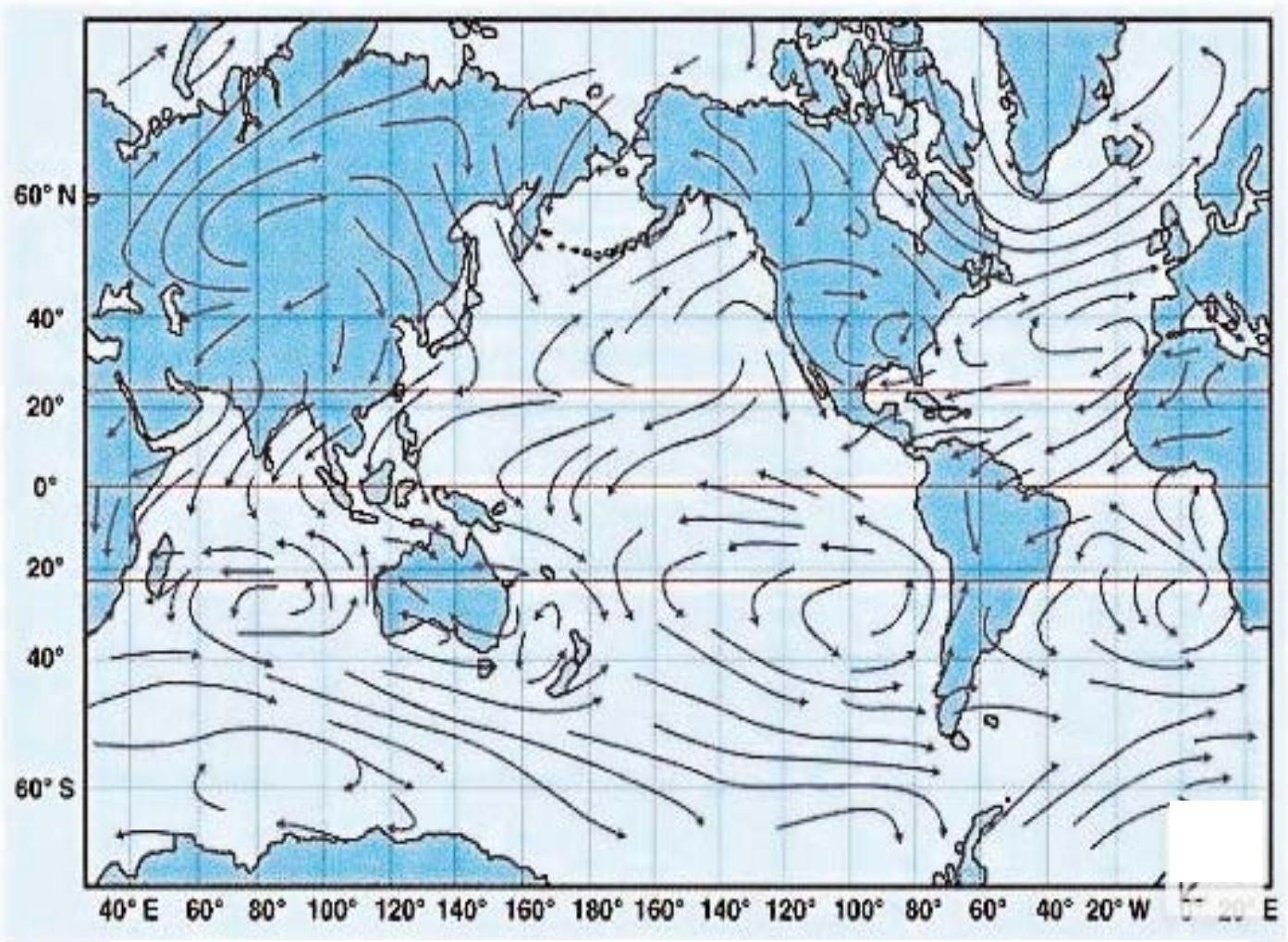
* depressions and anticyclones in temperate latitudes have characteristic scales of a few thousand (or tens of thousands) of km. The associated air masses have scales of a few hundred to a few thousand km. The typical size of polar lows is an order of magnitude less.

* tropical cloud systems have dimensions of a few tens to a few hundred km (occasionally more), but the associated gales and precipitation areas are small scale (a few km to a few tens of km)

* the major ocean currents have horizontal dimensions of a few hundred to a few thousand km (Gulf Stream, Kuro-Shio). Their mean latitudinal position exhibits some seasonal variation

* meandering currents and eddies (which increasingly appear to be the main vector for transporting energy horizontally, even vertically within the ocean) are small (a few km to a few hundred km)

In summary, the ocean receives energy from the atmosphere in different forms. It responds to this by modifying its vertical thermal structure and its currents more or less rapidly (faster cooling than warming in general). In return, the ocean only affects the atmosphere by modifying the surface temperature (we neglect the effect of currents, which generally have a speed well below one meter per second, whereas the average wind speed is 7 m/s), and by matter transfers (water, gas, particles). The differences in scale of the spatial and temporal variations between the two environments make the exchange processes very complex, which depend on the oceanic regions: the ocean is not a vast homogeneous surface for the atmosphere, although the heterogeneities are much weaker than on the continents.



Wind direction at the earth's surface (annual mean)

Life in the oceans

Three marine areas will hold our attention here, because of their geological importance: the limestone continental shelves, the coral reef ecosystem and the oases of the ocean floor.

A - The limestone continental shelves

In the chapter on sedimentation in the marine environment, we especially insisted, in section 3.2.2 above, on the fact that the erosion of the continents was the main contributor to the sediment load on the continental margin (terrigenous load). But this is not always true. Life in the oceans is sometimes so prolific that in some places it contributes enormously to this sediment load.

These places, they are vast: they are the continental shelves and the island platforms which are located, roughly, between the latitudes 30° N and 30° S (to simplify, let us say the tropical seas). On these plateaus, benthic life (that found on the bottom of the sea) is abundant, thanks to the combination of three essential elements for its proliferation: high intensity of illumination because in a shallow environment, warm temperature and a good oxygenation of the water thanks to the constant mixing. A large number of organisms secrete a calcareous skeleton (calcite or aragonite) which after the death of the organism contributes to the sediment load in the form of particles (allochemical load). In fact, on the shelves of the tropical seas, it is essentially these sediments resulting from biological production that dominate. The beautiful white sands of tropical beaches are a good example. We then speak of plateaus or limestone platforms.

The production rates of calcareous sediments are very high: figures of 1 m/thousand years (Ka) are quoted, which is huge on a geological scale. (The small calculation made above on the turbidite sedimentation rates indicates a rate of 30 cm/Ka, 3 times less than here). By way of comparison, the terrigenous sedimentation rate on the Mississippi delta is around 4 m/Ka, ie 4 times more than for the limestones. But it must be seen that the accumulation on a delta is localized at one point and does not extend over an entire plateau. It can be said that in general, the rate of calcareous sedimentation controlled by biological production greatly exceeds that of terrigenous sedimentation. Life therefore produces an impressive mass of limestone sediments and it is not surprising that the ancient sequences of sedimentary rocks are so rich in limestone.

B - The coral reef ecosystem

While the bulk of ocean biomass is found in plankton, the maximum biodiversity is found in coral reefs. Indeed, it can be said that the coral reef is today the depository and the ceuset of the greatest marine biodiversity, in the same way as the equatorial forest is for terrestrial biodiversity.

The coral

The main responsible for the construction of the current reefs is the coral. It has a rigid calcareous skeleton (aragonite), secreted by a colony of small organisms (polyps) and is capable of erecting a solid and voluminous framework. On this framework comes to be grafted a whole panoply of diversified organisms, animals and plants, which contribute to build and enlarge the building; it is a complex ecosystem, but extremely successful. Corals do not tolerate cold water or the absence of light. They will build reefs in warm water (over 18°C, preferably above 25°C) and in shallow water due to the abundance of light. This is why they are found only on the continental shelves and island platforms of the tropical zone. The coral structures rise several meters and even tens of meters above the seabed. In many cases, they control sedimentation.

The coral reef ecosystem is a very dynamic system: constructive forces and destructive forces oppose it. The growth of corals is rapid, bringing rapid growth of the building. Rates of 3 cm/year are quoted. On the other hand, destructive forces (wave energy, sea level fluctuations, temperature changes, predation, anthropogenic activities) can also be very effective. According to the dominant

forces, we will witness the destruction or the growth of the coral structure. In general, if the conditions that led to the establishment of the ecosystem are maintained over a long period and are not disturbed by catastrophic events (such as changes in sea level related to glaciations or plate tectonics), the reef system maintains rapid growth. This ecosystem, which relies mainly on the good health of a single element, coral, is now in danger.

Coral reefs are found on limestone continental shelves or island platforms in the tropics. They form barriers at the margins of continental shelves, and they are then called barrier reefs, or a fringe around volcanic islands, and they are called island reefs or atolls.

When corals establish themselves at the margins of continental shelves, they form a barrier to energy coming from the open sea. Coral reef constructions are also found at the margins of narrow platforms that develop around volcanic islands in ocean arcs, as in the case of the Lesser Antilles, or hotspot volcanoes, such as those in the Pacific. When we talk about coral reefs, we most often think of these atolls in Polynesia, with superb blue lagoons, paradise islands, palm trees, small bamboo huts, etc. , etc. These atolls are reefs that have developed after the formation of hotspot volcanoes, as these recede from their source. The following diagrams explain the formation of an atoll.

We know that the ocean floor gradually lowers relative to sea level as the oceanic plate that supports it moves away from the ridge that forms it, because of its progressive cooling. Because it is carried by an oceanic plate, a hotspot volcano will also gradually sink as it moves away from the hotspot that formed it. It should also be taken into account that the volume of the plate as well as that of the volcanic apparatus when the latter are at the height of the hot spot will decrease as the distance from the hot spot increases.

When a hotspot volcano has pierced the sea surface to form an island in the tropical zone, the shores of this island are bathed in warm, well-illuminated and oxygenated waters.

C - The oases of the ocean floor

For a long time, in fact until the discovery in 1977 of the oases of the ocean floor associated with hydrothermal vents, we had the quiet certainty that the whole chain of life on earth depended entirely on photosynthesis. The discovery of a very dense animal population associated with hydrothermal springs, at a depth of 2500 meters, in the absence of any light, was enough to upset this certainty. The discoveries were first made in two areas which were studied in detail at four sites each: on the Galapagos ridge and on the Pacific ridge at 13° N. These sites presented such a rich fauna that they were has given evocative names such as the Jardin des Roses, the Banc des Moules, the Jardin du Paradis, the Menu Fretin, etc. We know that there are not only hot springs at 350°C like those which form metalliferous sulphides. There are also warm springs, at 15 or 20°C, and intermediate ones (up to 40°C); it is mainly around these springs that the animal population is found. In fact, it has been realized that the water temperature in the densest stands does not exceed 15°C.

It was discovered that the biomass, that is to say the quantity of living matter per unit volume, is 10,000 to 100,000 times greater on these sites than in the surrounding environment. This biomass is made up of various forms, most of which are new to science. Among the dominant species are large tubeworms called Riftia , which live in a pearly white tube ending in a red plume and which form dense bushes, 2 meters high; by itself, an individual with a waist circumference of 4-5 centimeters can reach 1.5 meters in length. There are also two species of giant bivalves, kinds of mussels or clams, brittle stars, crabs, small gastropods, serpulid worms , sea anemones and small crustaceans that look like lobsters.

Rather than using light as the primary source of energy to synthesize carbohydrates as plants do (photosynthesis process), there are bacteria here that draw energy from a very abundant chemical element in the environment. hydrothermal vents, sulphur. This is the process of

chemosynthesis. These bacteria are found in symbiosis in the tissues of large tubeworms. To a certain extent, worms are therefore the first link in the food chain. It was also later discovered that large bivalves also possessed this chemotropic bacterium . Later, we discovered on the Atlantic ridge, kinds of small blind shrimps which cover the walls of the chimneys with very dense populations and which also have these chemotropic bacteria as symbionts .

Since then, it has been discovered that there are such oases outside the ocean ridges and that there are several situations that can cause the emission of fluids on the ocean floors. It was discovered there that chemosynthesis is not limited to sulphur, because there are faunas that depend on other products such as methane (CH4) and ammonia nitrogen (NH3).

LIFE IN THE ABYSS

The abyssal environment, where cold and darkness reign, covers 307 million square kilometers, or two-thirds of the surface of the globe. It has long been considered a desert: no light, no photosynthesis, and the only organic matter that feeds the food chain comes, by gravity, from the surface, degrading during the descent. It functions as a sewer, a receptacle for corpses and excreta from the lighted area of the ocean.

An immense "almost desert"...

The abyssal environment, with its 307 million square kilometres, represents two-thirds of the surface of the globe. If it has long been considered a desert, it is because of its absence of light and photosynthesis, which does not allow the development of life.

The abyssal biomass is between a few grams and a few milligrams per square meter. The organic flux is however marked by a seasonal variation, especially in temperate zones. It can cause an accumulation of organic matter on the bottom during surface planktonic blooms. In the days that follow, this organic matter is at the origin of a veritable proliferation of invertebrates and unicellular organisms. The benthic "bloom" lasts only a few weeks and disappears as soon as the organic matter is exhausted.

... and rich in species

The notion of biodiversity expresses the variety of biological systems that inhabit an ecosystem. In its simplest sense, it is measured by the number of species present. The total number of known species in the biosphere is now estimated at 1.3 million, and probably 5 to 10 million species the total richness, although higher estimates have been made taking into account the populations of canopy (up to 30 million according to some estimates).

The contribution of the deep domain is still poorly understood. The group of American researchers who studied the northwest Atlantic continental slope between 1,500 and 2,500 meters estimated, by extrapolation, at around 10 million the number of species present in the deep domain. But much higher estimates have been made, taking

into account not only the small fauna greater than 250 µm but also those whose size is between 250 and 40 µm.

Hydrothermal springs

The hydrothermal environment is made up of the outer part of the mixing zone between, on the one hand, the overheated, acidic fluid (pH 3-4), loaded with mineral elements, many of which are toxic (heavy metals, sulphides, radioactive compounds), devoid of oxygen and on the other hand, cold seawater, well oxygenated, and whose pH is slightly basic (pH 7-9).

The geometry of this biotope is complex, since a significant part of the mixing occurs in a network of conduits or reservoirs located in the subsurface. The smoker itself is surrounded by numerous lukewarm vents with an intermediate temperature. Thus, hydrothermal water which results from the mixing, is emitted by the cracks in the basalt and through the scree without it always being possible to individualize real vents.

An unstable environment

This mixing, between two so different fluids, produces mineral precipitations and strong turbulences, which are translated by rapid variations of the temperature and the chemistry of the medium in a fixed point, the medium passing continuously from a hydrothermal influence to a predominant oceanic influence.

The horizontal gradients are obviously steeper than the vertical gradients: a submersible can thus easily approach laterally a hot source (350°C) to take samples from it without taking risks for its safety, but it cannot pass to the over a smoker! In addition, the hydrothermal biotope is also under the effect of bottom currents, in particular alternating tidal currents.

A halo distribution

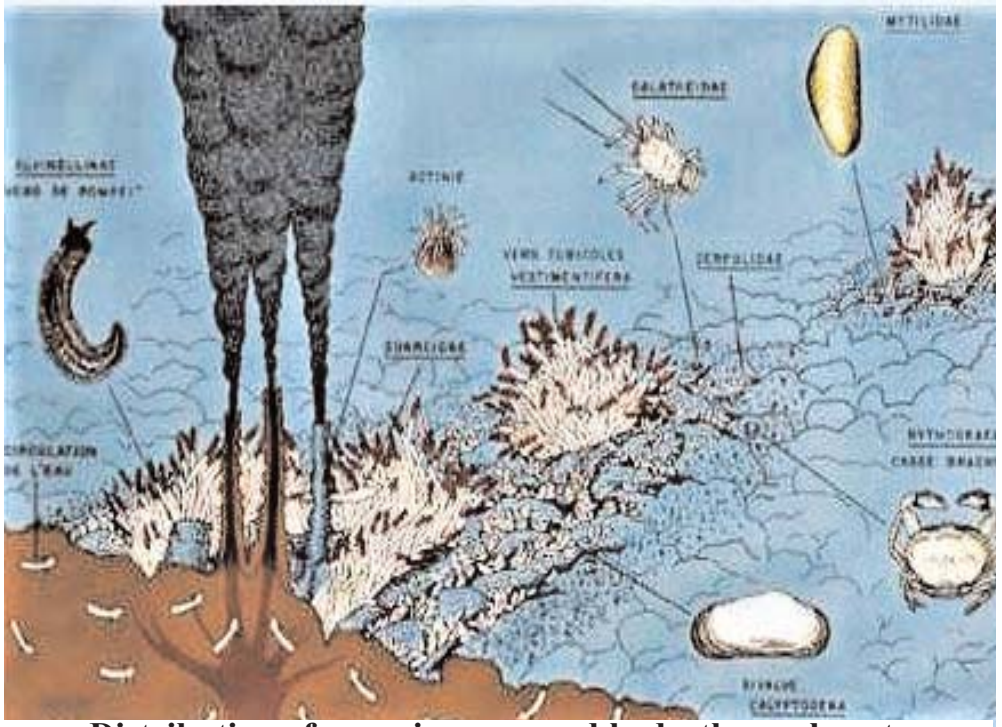
In a hydrothermal site, the organisms are distributed according to their physicochemical preferences, and their ability to resist the aggressiveness of the environment. We thus observe a distribution of the different species in concentric aureoles around the hydrothermal vents.

A typical distribution of the main species can be described, with three concentric circles formed:

1) grazing species of bacterial mats;
2) symbiotic associations between bacteria and invertebrates;
3) particle filtering species.

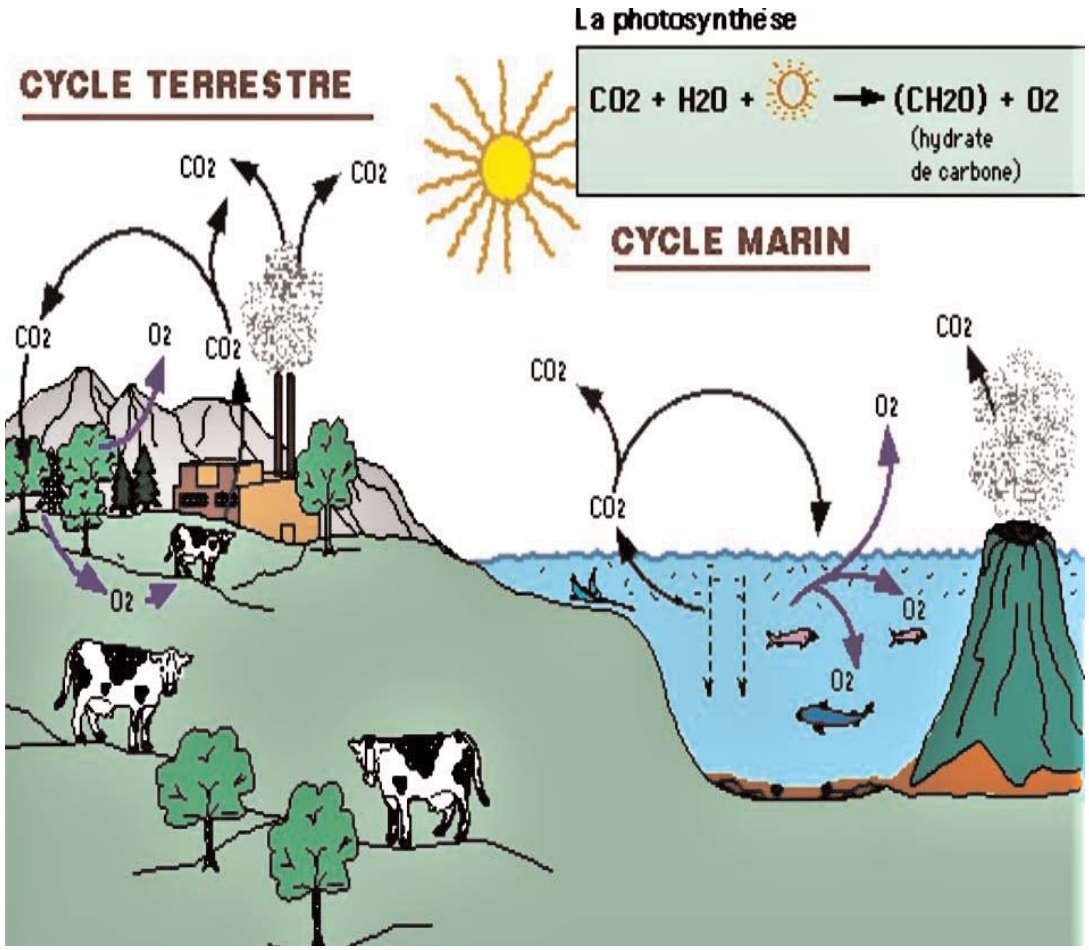
Could the hydrothermal environment have been the place of synthesis of the first organic molecules, where the first forms of life would have developed on Earth?

Several arguments could support this hypothesis of the origin of life on Earth, proposed shortly after the discovery of hydrothermal vents by three American researchers.



Distribution of organisms around hydrothermal vents

The source of life: the arguments for the hypothesis



Here are the four arguments in favor of the hypothesis presented above:

1) in the phylogenetic tree obtained by molecular techniques, the organisms closest to the root common to the three domains of life are all thermophilic or ultrathermophilic microorganisms, very abundant in the deep hydrothermal environment;

2) the layer of water overhanging the ridges, although probably less thick in the primordial ocean, could have protected the primitive forms of life from destruction by UV rays and the meteorite impact;

3) the hydrothermal buildings could have formed veritable "incubators", due to the existence of strong thermal gradients and multiple catalytic mineral surfaces. On the other hand, hydrothermal fluids contain a large quantity of numerous elements essential for syntheses (H2, N2, H2S, CO, CO. 2, etc.);

4) hydrothermal vents have existed in very similar forms during a very long period of the Earth's history.

Hydrothermalism was much more active in the early ocean. This seductive hypothesis has been and still is the subject of debate and controversy, as are all those relating to the origin of life on earth. A great deal of research is continuing in this field, known as "exobiology", in order to demonstrate or disprove each of the complex steps leading from elements of mantle origin to the first living cells.

An ultrathermophilic biosphere ?
Today, several clues are put forward to support the hypothesis of the existence of a ubiquitous ultrathermophilic biosphere that would develop in subsurface reservoirs and in rocks:

1) observation of the emission of bacterial flocculates by warm vents from submarine springs;
2) the study of the optimal growth conditions of the bacterial strains sampled in these fluids shows a shift which suggests that they are adapted to higher temperatures and pressures than those in which they were sampled;
3) the occurrence of similar, thermophilic and moderate halophilic microbial strains in hydrothermal springs, oil reservoirs, groundwater, may suggest a present or recent interconnection between these environments;
4) the emission in the hydrothermal fluids of high concentrations of ammonia and methane, even in the absence of sediment rich in organic matter;
5) studies of biological alteration of lavas show that the action of

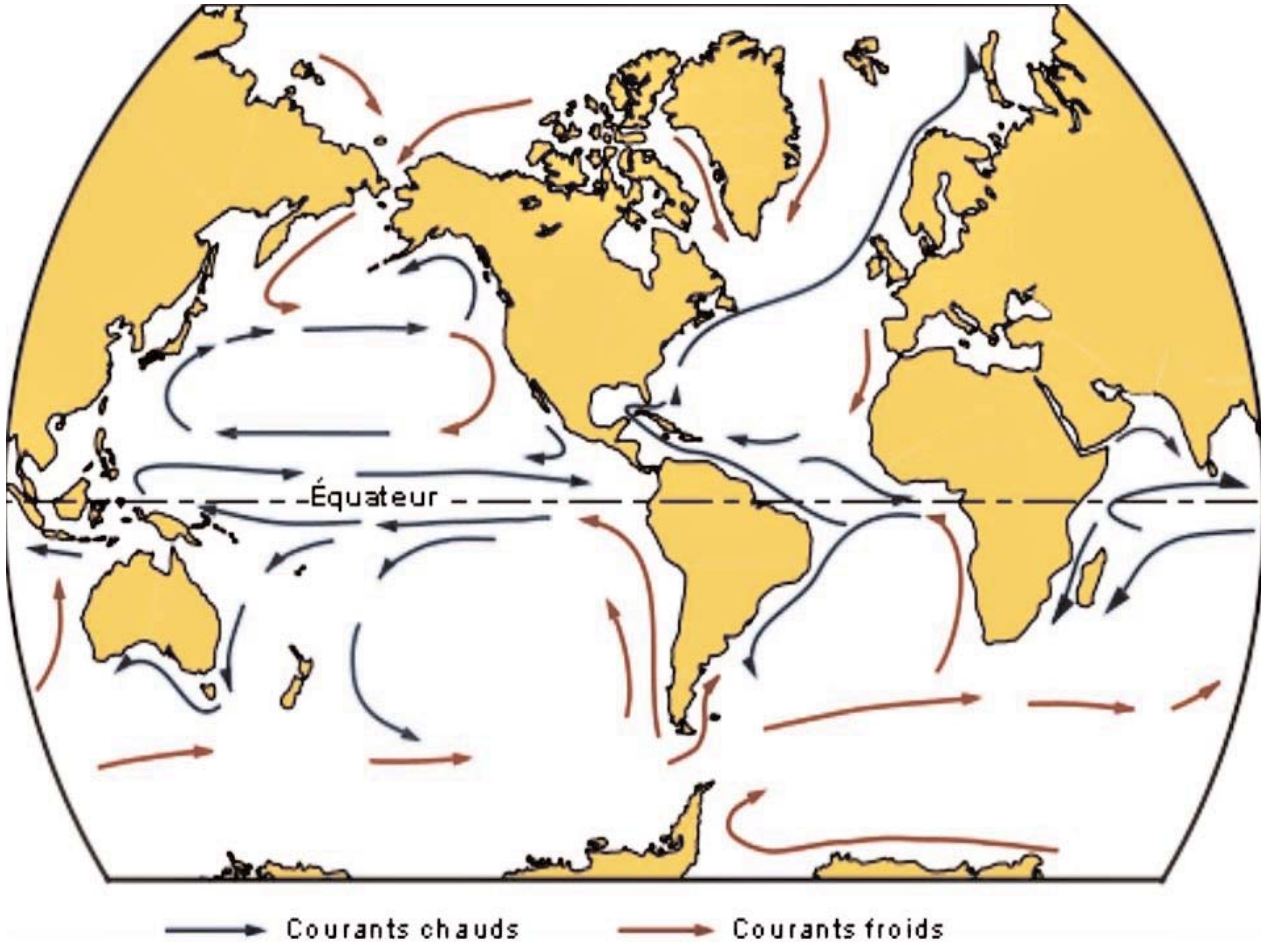
hyperthermophilic microbes is important in boreholes up to about 500 meters, it decreases quite rapidly thereafter.

Based on these arguments, and a few others, astrophysicist Thomas Gold hypothesized that a second biosphere, potentially larger than the one known at the interface, would exist inside the crust. terrestrial to depths of 10 kilometres. The microorganisms that would live there would obtain their energy by metabolizing the hydrocarbons that permeate the planet.

And global warming in all this?
Under the effect of warming, many planktonic species adapted to temperate waters migrate towards the less and less cold waters of the north, taking with them their predators, which modifies the balance of the system. In addition, the accumulation of CO2 in the ocean threatens the proper functioning of the biological pump by causing ocean acidification. This ongoing acidification could alter the rhythm of the biological engine of the ocean carbon pump.

The ocean regulates atmospheric temperatures

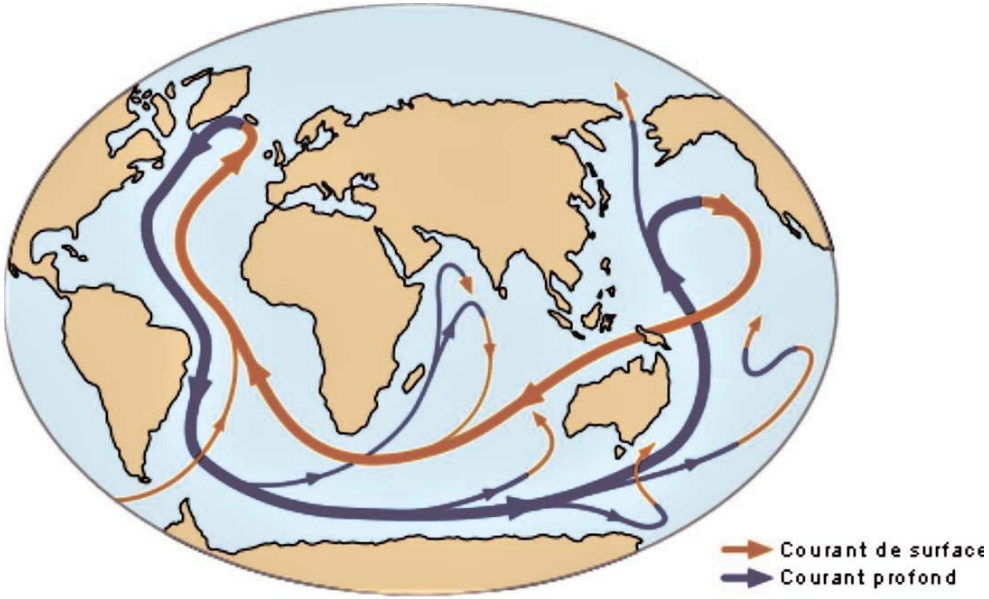
During the summer period, the ocean absorbs strong solar radiation at the level of the equatorial and tropical zones, stores it and then redistributes this heat thanks to the various ocean currents which move the masses of hot water towards high latitudes and the masses of cold water towards the equatorial and tropical zones where they come to warm up. Deep currents are not directly influenced by wind patterns, but rather are controlled by changes in temperature and salinity of water masses. Oceanographers have recognized an important cycle of ocean circulation on the scale of all the oceans and on a time scale of the order of a thousand years. It is a loop that originates in the North Atlantic where cold (cooled by the cold Canadian winds), salty, dense and well-oxygenated waters plunge to the depths, flow south over the ocean floors all along the Atlantic, cross the Indian Ocean, then go up north along the Pacific, to resurface in the North Pacific, cold and poorly oxygenated. These waters are warmed and oxygenated throughout their surface course, from the Pacific to the Atlantic, and, cooled again in the North Atlantic, plunge to start the cycle again. It takes about 1000 years for a round



This north-south exchange has a strong influence on atmospheric temperatures. It is estimated that if there were not this regulator, the flow of heat from southern latitudes to high latitudes would be half as much, with the consequence that the contrasts between climates would be even more accentuated: it would be colder at the poles and warmer at the equator.

trip. It is the global ocean (according to Broeker , 1995, Scientific American, v. 273).

Atmosphere and ocean form an intimately linked couple. Atmospheric circulation influences ocean currents and vice versa. The best example of this intimate relationship is the El Niño phenomenon, a very topical subject (late 1997).



The ocean regulating its own salinity

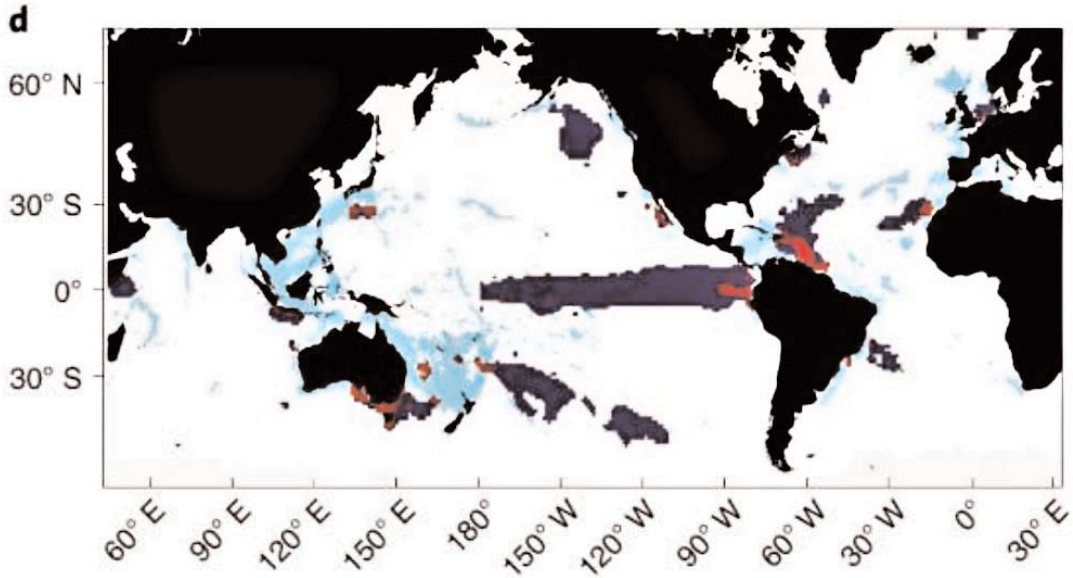
Who hasn't wondered one day why the water in the sea is salty while that of the lakes and rivers is not? Marine water indeed contains a relatively large quantity of dissolved "salts" (and not only salt, NaCl). The primary constituents of sea salts are, in order of importance, chlorine ions Cl- (18.98 g/kg), sodium Na2- (2.65 g/kg), magnesium Mg2+ (1.27 g/kg) , calcium Ca2+ (0.40 g/kg) and potassium K+ (0.38 g/kg). Except for calcium, the quantity of which can vary from place to place, the proportion between each of the ions is fairly constant across the oceans. With other ions in smaller quantities, these main ions account for 35 g/kg on average in the oceans, which is more commonly expressed in per thousand, or 35‰, the so-called normal salinity of the ocean. We saw in section 2 of the course that these ions can bind together to form the minerals of the evaporitic sequence, calcite (CaCO3), gypsum (CaSO4.nH2O), halite (NaCL , table salt) and sylvite (KCl).

Where do these ions come from? All these ions come from the superficial weathering of rocks.

The water that circulates on and in the rocks monopolizes the soluble ions and transports them towards the ocean. It is estimated that rivers bring between 2.5 and 4 billion tons of dissolved salts to the oceans each year. The water evaporates on the surface of the oceans, leaving behind the salts. Some of this evaporated water (pure, salt-free water) returns to the continents where it runs off, weathers rocks and brings new salts back to the ocean. By continually receiving ions in this way, the oceans would gradually become saltier!

This is what an Irish scientist (John Joly) believed at the beginning of the 20th century. You should know that at that time, the radioactivity that we use today to date rocks was not known (the method was only developed in the middle of the 20th century) and that consequently the age of the Earth could not be more misunderstood; we clung to the age of 100 Ma that Lord Kelvin had "calculated" in 1866. This Irishman therefore said to himself, from an old idea of a British astronomer (Sir Edmund Halley) from the beginning of the 18th century, that if the ocean had started to get "salty" at the beginning of the Earth's history, it was only a matter of dividing the total volume of salts in the current ocean by the volume brought in each year by the rivers to know the number of years it took to bring all this salt, therefore the age of the Earth. His calculations led him to propose an age of between 80 and 89 million years, a rather "conservative" age compared to the age of 4.55 billion years (4550 million years) that the was determined by the radiometric method. In fact, if we resumed Joly's calculations with the values of the volumes that we evaluate much better today, we would arrive at an age of ... 13 million years!

So we have to conclude that the ocean annually gets rid of a quantity of salt equal to that brought to it by the rivers. So you need salt wells. In certain coastal regions of the Globe, significant evaporation contributes to precipitating the minerals of the evaporitic sequence and to storing these salts in the sediments and sedimentary rocks. The uptake of several ions by plankton or benthos organisms which use them to form their mineralized skeleton or shell (CaCO3, SiO2); after the death of the organism, the mineralized remains settle on the seabed and are incorporated into sediments and sedimentary rocks.Sea spray is made up of salt water, since it is not evaporation but downright fine droplets carried by the winds to continental coastal areas. On the surface of the oceans, tiny bubbles of air come to burst (like on the surface of your glass of pepsi or your glass of champagne, it is according to your habits of consumption) projecting salty water which immediately evaporates, leaving tiny crystals of salts which are carried by the ascending winds towards the atmosphere and transported towards the continents where they will be deposited with the rains. In short, the current salinity of the oceans does not represent the result of a progressive accumulation of salts, but the balance between what enters and what leaves the ocean.

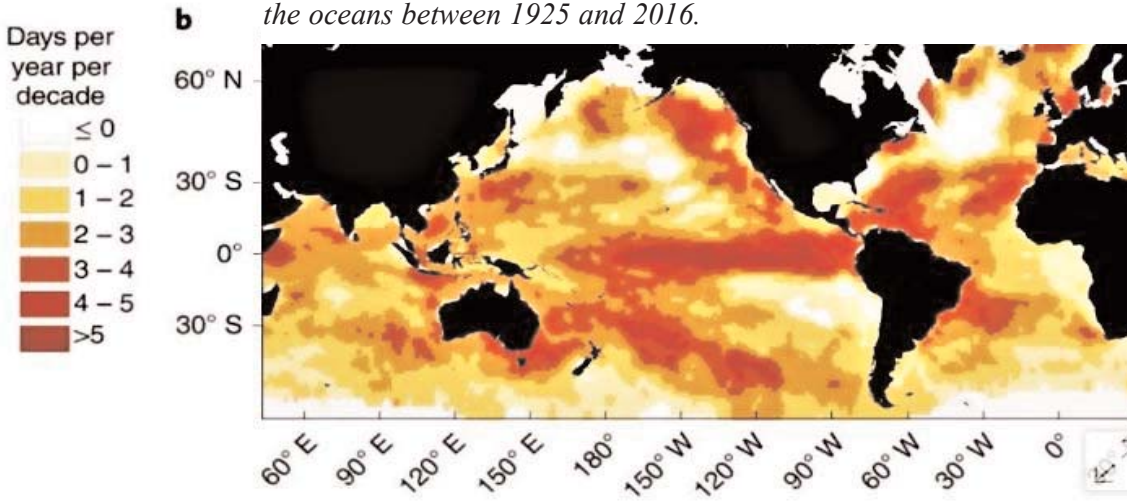


*Biodiversity hotspots that may be threatened by marine heat waves. In blue: medium-intensity heat waves, high biodiversity. In purple: high intensity heat waves, biodiversity of average richness. In red: high intensity heat waves, high biodiversity. © Dan Smale et al*Nature Climate Change, 2019

The ocean regulator of atmospheric oxygen

A geochemical cycle essential to our survival is largely controlled by the ocean. This is the cycle of free oxygen (O2). If life has been able to maintain itself and proliferate on the surface of the globe, it is because it has invented a defense mechanism against this violent poison for it which is oxygen. This mechanism is breathing. At the same time that she was inventing this mechanism, she was becoming dependent on it.

Oxygen is essentially a by-product of photosynthesis, the process which, starting from CO2 and water, uses solar energy, light, to fix carbon in carbohydrates (CH2O), the matter of first plant cells, or even very simple forms of bacteria. This reaction releases oxygen as expressed by the equation at the top of the following diagram.



Number of additional days of heat wave per year and per decade in the oceans between 1925 and 2016.

At the level of the continents, the vegetation, for example the large forests, produces a certain quantity of oxygen thanks to the photosynthesis activity of the plants. Some of this oxygen is used by animals to breathe. Another part is used to oxidize dead organic matter that comes from plants and animals. The excess is released into the atmosphere. The net balance, over several years, of a forest in equilibrium is practically nil. That is, it consumes as much oxygen as it produces, providing no significant amount of oxygen to the atmosphere. This is why it is an exaggeration to call the great Amazon rainforest the lungs of the Earth. (There are many other reasons for wanting to protect the Amazon rainforest, but not this one).

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The ocean that regulates atmospheric carbon dioxide

The ocean is the regulator of another atmospheric gas important for our survival: CO2. The latter is responsible for this greenhouse effect which has allowed the maintenance of life on earth. CO2 is a gas produced by the oxidation of organic matter, including the respiration of animals and the combustion of oils and coals that are derived from organic matter. Volcanoes also emit a certain amount of CO2 into the atmosphere. The ocean consumes a large amount of CO2, either by dissolving it in water, or by using it for photosynthesis, or by incorporating it into CaCO3 for the manufacture of the shells of organisms.

The threat of heat waves in the oceans

Heat waves also hit the oceans. They occur more and more often and for longer and longer durations. Globally, the number of "sea heat wave" days, marked by abnormally high surface temperatures, increased by 54% between 1925 and 2016, with an apparent acceleration of the phenomenon over the past 30 years. A study published in Nature Climate Change looked at the impacts of this intensification of heat waves on marine ecosystems, which include the reduction of fish stocks and the loss of habitats.The researchers identify several particularly threatened areas in the Pacific, Atlantic and Indian Oceans, as they are home to very rich biodiversity and species already living in warmer waters. In some of these regions, other anthropogenic threats, such as overfishing and pollution, add to the effects of heat waves. The researchers also note a link between the increase in the number of days of heat wave in the year and the destruction of the pillars of ecosystems (kelp forests, seagrass beds, corals). Unfortunately, it is to be expected that these heat waves, and therefore their impacts, will increase further with the long-term trend of global and ocean warming.

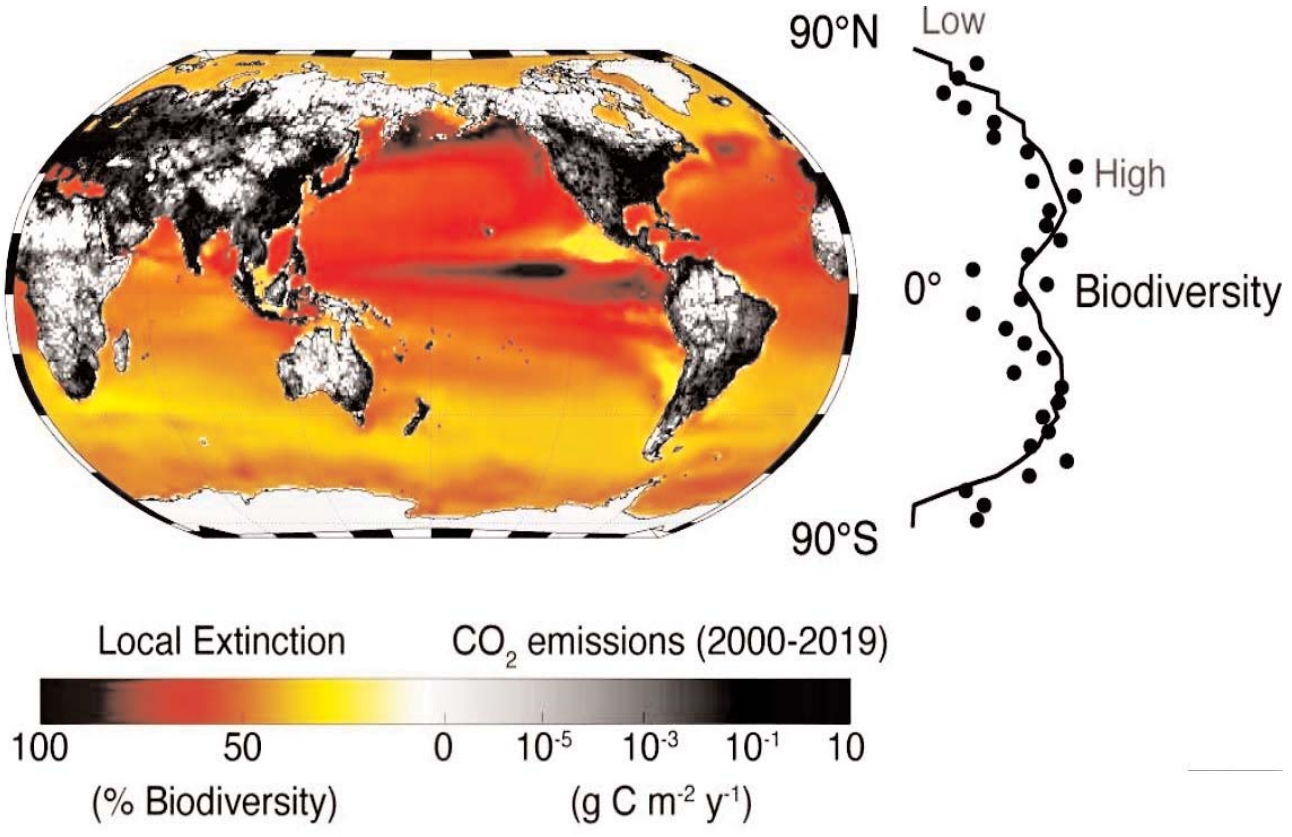
Our planet is heating up. Its atmosphere, in which we live, we humans, is heating up dangerously. Temperatures that are becoming more and more difficult to tolerate. Unfortunately, the problem is not limited to the atmosphere. Earth's oceans are also warming. With the consequence of losing part of their oxygen. And researchers from Princeton University (United States) warn us today: At this rate, marine biodiversity could fall over the next few centuries to a level it has not seen since the extinction of the dinosaurs.

To reach this conclusion, the researchers combined the physiological data they had on marine species with models of global warming. Their objective: to predict how changing conditions will affect the survival of its populations in the future. The bad news is that the model they have thus established seems to want to follow a pattern identical to that which took place during the greatest mass extinction known to our Earth. It was about 250 million years ago. Over 80% of marine species bowed out by then.

Researchers explain it this way. With anthropogenic global warming, the temperature of the ocean is increasing. A risk factor in itself for species adapted to cool climates. But hot water also contains less oxygen. And it circulates less easily, which makes it difficult to transport the remaining oxygen to the depths. To top it off, it turns out that marine species need even more oxygen when temperatures rise.
Stopping our greenhouse gas emissions to save marine life

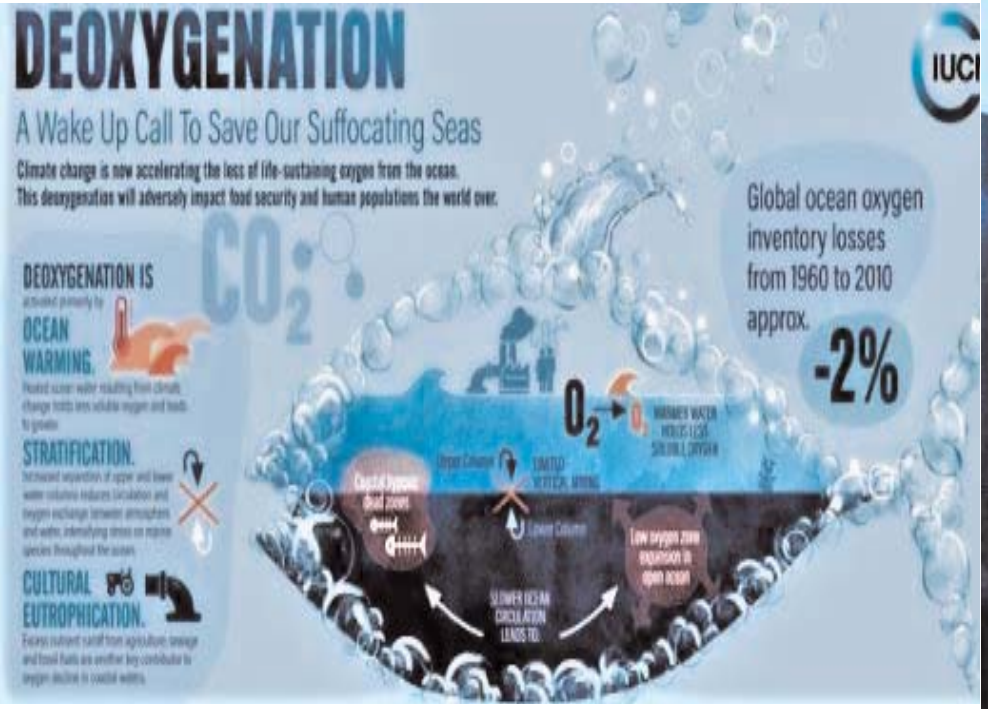
Thus, the polar species seem the most threatened with total extinction. Because they will struggle to find suitable habitats in which to move. Tropical species will be able to move to cooler regions as temperatures rise. And these are species already adapted to low oxygen levels in the water. For her, the loss of marine biodiversity could remain confined to a more local level. Even if it looks like a major. On the side of the equator, on the other hand, the warming could sound the death knell of all life. The ocean there is already so warm that a further rise in temperature would likely make it uninhabitable.

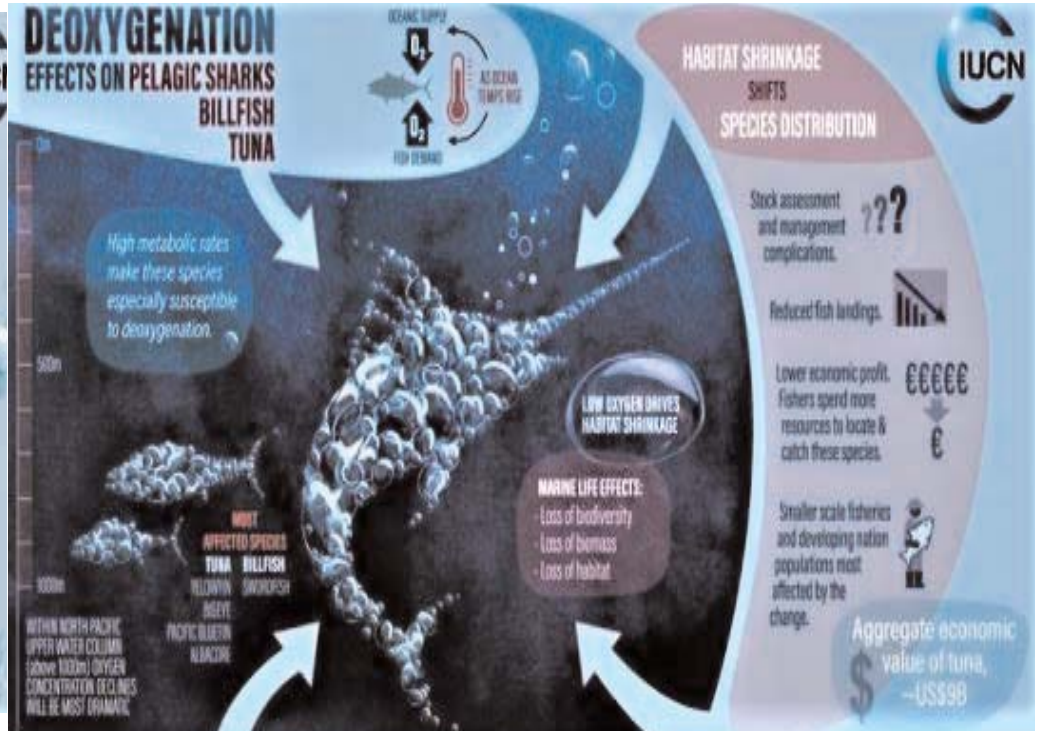
It's a bit like what happened around 250 million years ago. With the trigger at that time, volcanic eruptions which reduced the availability of oxygen in the ocean. But similar geographical differences observed in the fossil record for the disappearance of marine species. According to the researchers, therefore, by the end of this century, global warming will have become as harmful to marine species as all the other stress factors recognized by the International Union for Conservation of Nature (IUCN). Among which especially today overfishing, transport, urban development and pollution.



Among the effects of global warming is the deoxygenation of the oceans. An effect that researchers have tried to quantify. According to them, by 2080, no less than 70% of our oceans could lack oxygen. And a lot of fish with them...

Scientists have long known that with climate change, the oceans are losing their ability to transport dissolved oxygen. Oxygen that aquatic animals need to live. But researchers from the University of Shanghai (China) are now presenting new disturbing results. According to them, by 2080, about 70% of the world's oceans could lack oxygen. With a major impact on fisheries.


DEOXYGENATION
A Wake Up Call To Save Our Suffocating Seas
Climate change is now accelerating the loss of life-sustaining oxygen from the ocean.
This deoxygenation will adversely impact food security and human populations the world over.
DEOXYGENATION IS
OCEAN WARMING.
STRATIFICATION.
CULTURAL EUTROPHICATION.
Global ocean oxygen inventory losses from 1960 to 2010 approx.
-2%

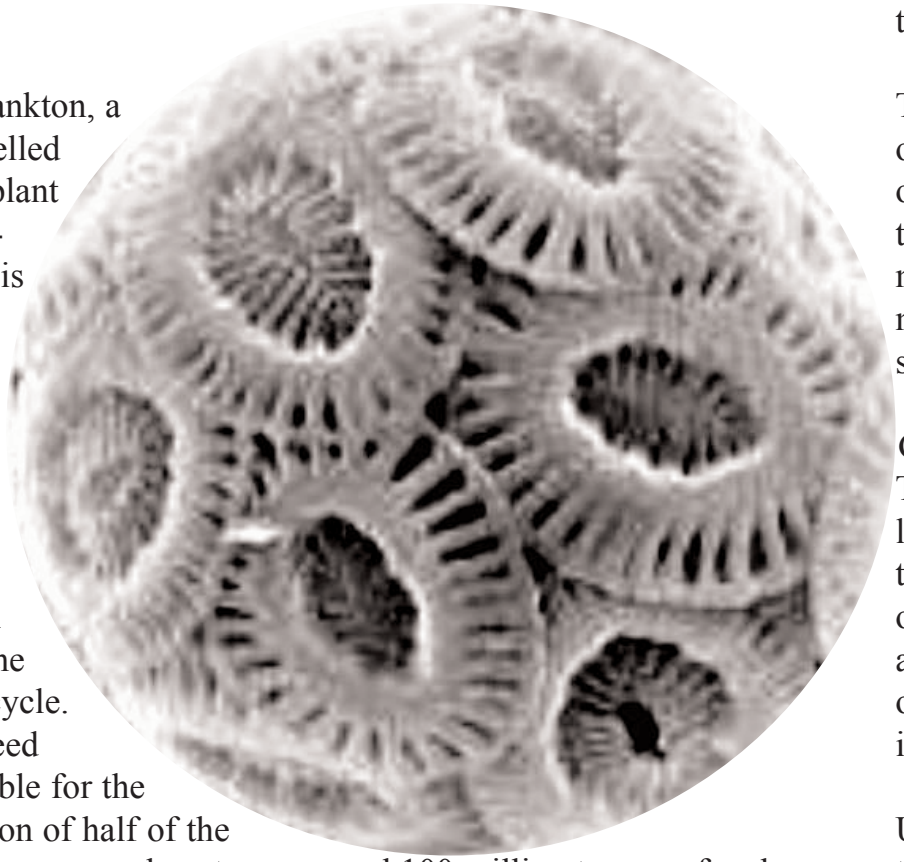

DEOXYGENATION
EFFECTS ON PELAGIC SHARKS
BILLFISH
TUNA
IUCN
HABITAT SHRINKAGE
SHIFTS
SPECIES DISTRIBUTION
High metabolic rates make these species especially susceptible to deoxygenation
LOW OXYGEN DRIVES HABITAT SHRINKAGE
MARINE LIFE EFFECTS:
- Loss of biodiversity
- Loss of biomass
- Loss of habitat
Stock assessment and management complications.
Reduced fish landings.
Lower economic profit. Fishers spend more resources to locate & catch these species.
Smaller scale fisheries and developing nation populations most affected by the change.
Aggregate economic value of tuna, ~US$9B

To predict how and when the deoxygenation -- understand, the reduction of the dissolved oxygen content in the waters -- of the oceans will occur, the researchers worked on climate models. On a scenario of high emissions and another of low emissions. The researchers divided the oceans into three subsets: the deep ocean, the middle ocean, and the shallow ocean. They then modeled when the loss of oxygen in the water exceeds natural fluctuations in oxygen levels. The researchers note that "significant and potentially irreversible" deoxygenation began to occur in 2021 at moderate depths.

Whatever the scenario, this area is the one that loses its oxygen the fastest. But the process begins 20 years later with the low emission scenario. Evidence that reducing emissions of carbon dioxide (CO2) and other greenhouse gases could help delay the degradation of global marine environments. Although the researchers acknowledge that it is unclear at present whether dissolved oxygen would return to pre-industrial levels.

To absorb atmospheric CO2, to produce oxygen or because it is the first link in the marine food chain, phytoplankton is essential to life. However, researchers note today that its productivity has been declining since the beginning of the industrial era.

At sea, phytoplankton are at the base of the food chain. It also absorbs some of the carbon dioxide (CO2) emitted by humans into the atmosphere. And it produces oxygen. However, researchers from the Massachusetts Institute of Technology (MIT - United States) are now noting that the productivity of phytoplankton is declining in the North Atlantic. One of the most productive marine basins in the world.



Phytoplankton, a single-celled marine plant microorganism, is the base of the ocean food chain and plays an essential role in the carbon cycle. It is indeed responsible for the production of half of the earth's oxygen, and captures around 100 million tonnes of carbon dioxide per day... It is the "biological pump" which is beating energy. wing.

Researchers note a 10% decline since the start of the industrial era. A decline that coincides with the rise in surface temperatures of the oceans since the middle of the 19th century. This figure, they obtained it by tracing deposits of methylsulfonic acid (CH4O3S). Because the only known source of these deposits is phytoplankton.

Indeed, an article published in Nature panics the troops: the phytoplankton would be slowly disappearing. The phytoplankton cycle is complex and fluctuates with season and location; it is therefore difficult to determine a trend in the evolution of this marine microorganism. Despite everything, it seems that the quantity of phytoplankton declines by about 1% per year. Since 1950, the total quantity of phytoplankton has even suffered a reduction of 40%.

These data were obtained by carrying out precise measurements over a long period of time. Since 1899, the transparency of the ocean has been measured regularly, using the technique of plunging the Secchi disk into the water until it visually disappears. Other more modern measurements have also been carried out: measurement of chlorophyll and observation of the color of the ocean by satellite.

Global warming in question

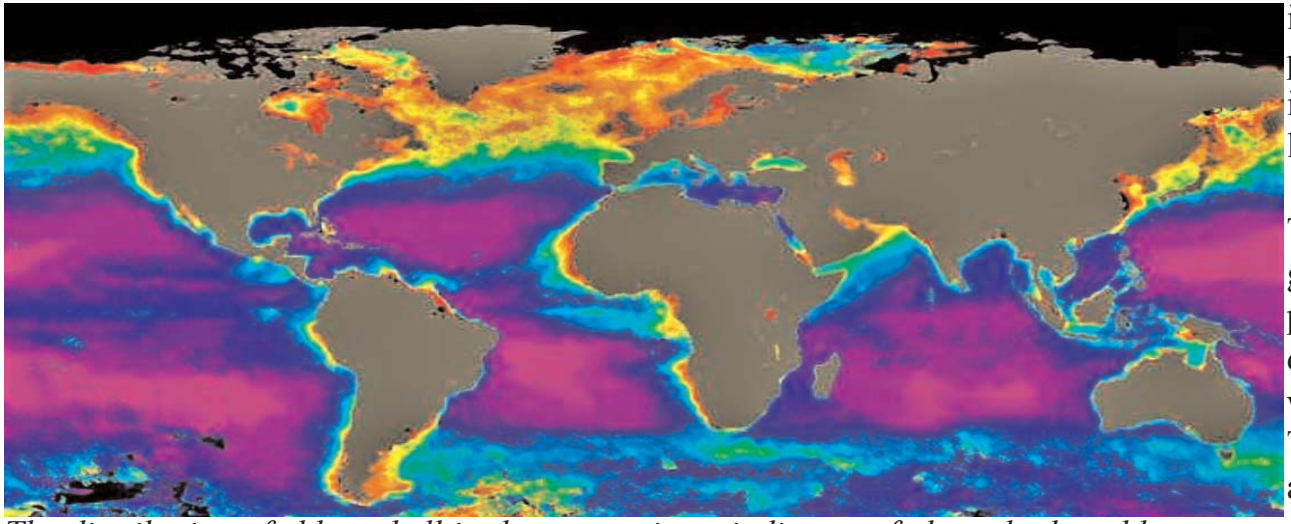
The correlation of the three measurements, added to multiple others, led researchers from Dalhousie University in Canada to conclude that the population of phytoplankton has dropped in eight of the ten oceans studied. This is particularly observed in the South Atlantic and equatorial oceans, and at the poles, in the Arctic and Antarctic oceans. The Indian Ocean is the only one that shows signs of increasing phytoplankton biomass.

Unfortunately, despite the technical and scientific difficulties that these observations have created, Canadian researchers are convinced of their results, which they have studied from all angles. All the data overlap and lead to the same conclusions.

The reasons for such an evolution are probably simple: the warming of the ocean is certainly the main cause. The upper part of it has warmed by about 0.5 to 1°C over the last century, accentuating the effect of ocean stratification and thus limiting the exchange of nutrients between deep water and surface water.

The reduction in the biomass of phytoplankton is one of the real phenomena of the modification of the balance of the ocean. It will certainly contribute to the impoverishment of the population of marine animals, both fish and mammals. The disappearance of the coral, the acidification of the water, overfishing... All these problems accumulate without us really knowing what the long-term consequences will be. What is certain is that the evolution of the marine environment, a good reflection of the health of our planet, must be closely monitored.

Climate models predict a gradual increase in ocean temperature by 2100. Phytoplankton from the tropics, which are particularly sensitive to warming, will move to higher latitudes to survive. With this migration of plant organisms at the base of the food chain, what will happen to tropical fish?
The warming of the oceans, predicted by current climate models, modifies the productivity of phytoplankton. These marine microorganisms, at the beginning of the food chain, are essential to biogeochemical cycles and important for fish. They also manufacture organic matter from the process of photosynthesis and are therefore a CO2 sink. A study, published on October 25 in the journal Science, shows that in 2100, in response to the warming of the seas, more than a third of tropical phytoplankton will migrate towards the poles.

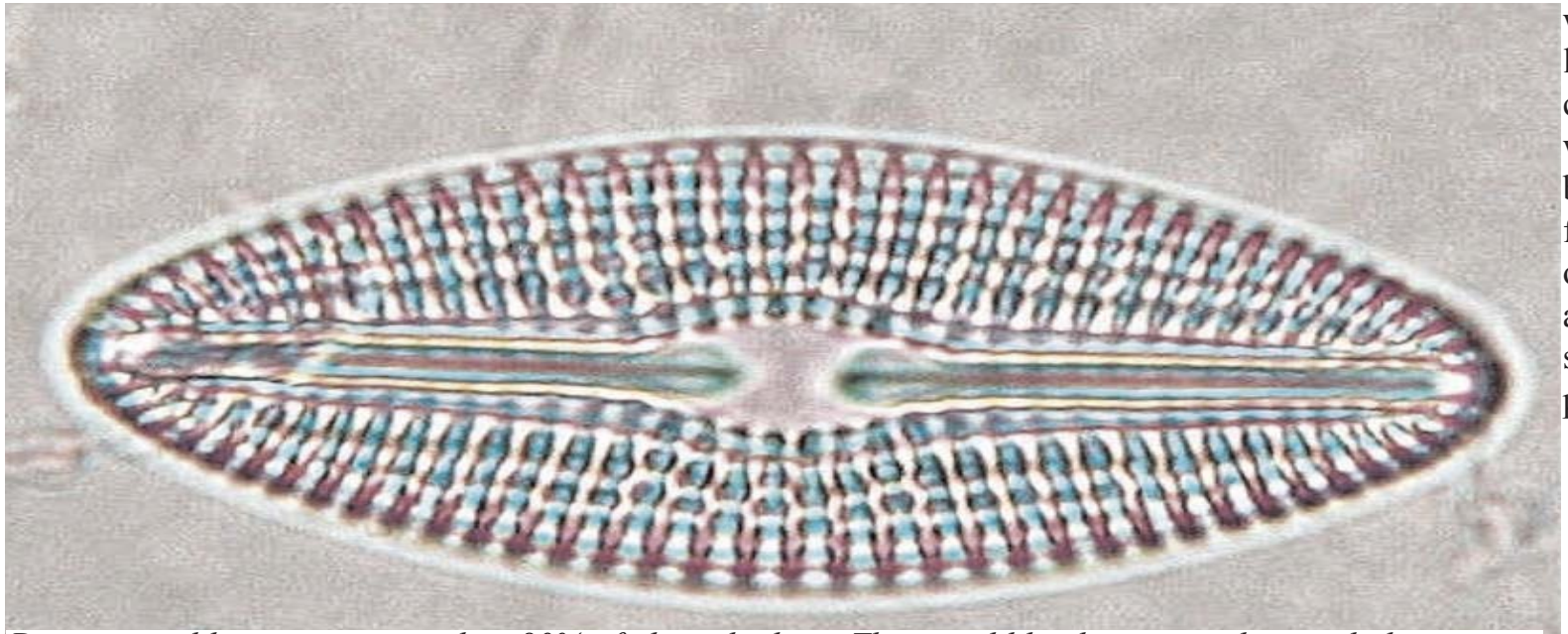


The distribution of chlorophyll in the oceans is an indicator of phytoplankton bloom zones. Present only in the surface layer of the oceans, since they require sunlight for photosynthesis, these microorganisms are mainly distributed in the upwelling zones of the oceans. © Nasa

Before being inserted into numerical climate models, some 130 species of phytoplankton distributed throughout the world were studied. The driving idea was to assess in situ the sensitivity of phytoplankton to temperature variations: what is the maximum temperature that phytoplankton in a certain region can withstand? Each species has, according to the characteristics of the area where it is found, a specific sensitivity.

Using decades of previously published data, the University of Michigan team determined the peak production rate of phytoplankton and their associated optimum temperature. According to Mridul Thomas, main author of the publication, at the poles and in a temperate environment (typically at the latitude of France) micro-organisms develop at a temperature below the optimum production temperature. Thus, one can easily imagine that an increase in temperature at these latitudes will not affect the species.

Tropical phytoplankton are more sensitive to global warming In contrast, in tropical regions, phytoplankton is currently at the optimum production temperature. This is one of the reasons why blooms are important at these latitudes. Tropical species would therefore be more vulnerable to ocean warming. The better adaptability of certain species to the highest latitudes remains an unanswered question in the scientific community.



Diatoms could represent more than 80% of phytoplankton. They would be the most widespread plant group and designate more than 6,000 species

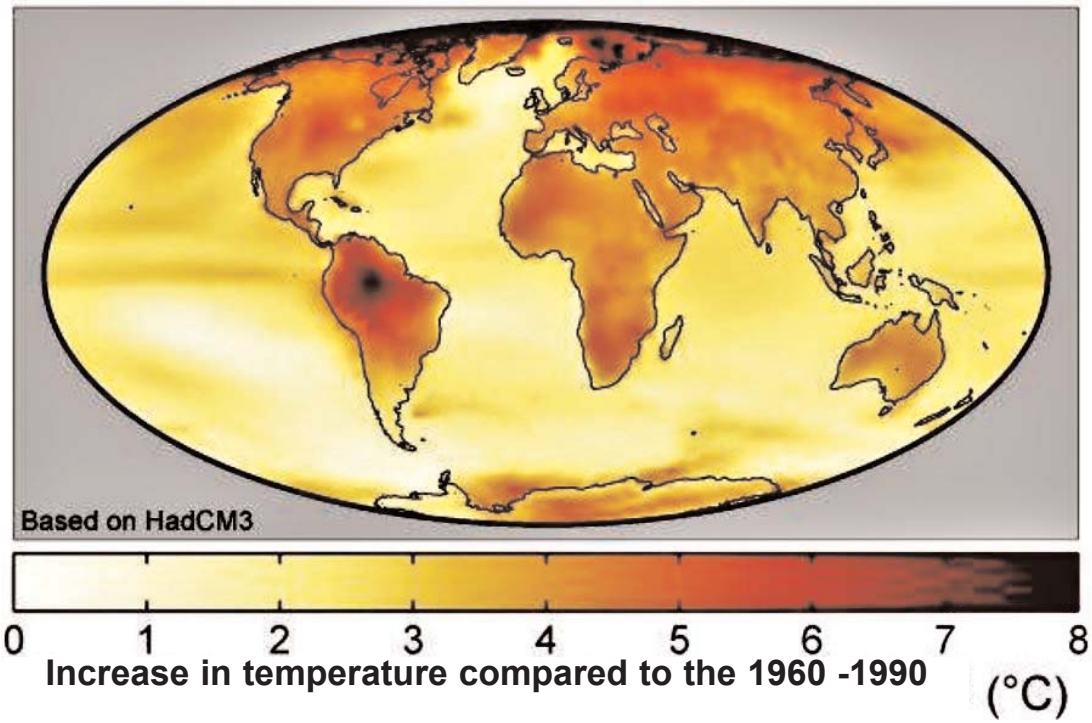
will not migrate. Either way, living conditions in the tropical oceans will change and wildlife will have no choice but to adapt or disappear. Fish fond of these tropical microorganisms will also have to adapt, they will have to consume other species of phytoplankton at higher latitudes.

Nevertheless, with this knowledge of the sensitivity of phytoplankton to its environment, the research team assessed the theoretical response of tropical plant microorganisms to global warming. Simulations of climate models, based on scenarios of increased temperature, show that a third of tropical species would migrate towards the poles by 2100.

These results suggest that in the tropics, many species of phytoplankton are at risk of extinction, unable to adapt to the rise in temperature . However, temperature is not the only climatic parameter that directs the production of phytoplankton. But according to the team, adding environmental factors, such as the supply of nutrients or the variation in oxygen in the ocean, to the models will only identify the habitats of the species.

No one really knows how quickly phytoplankton adapt to variations in the environment in which they live. We cannot therefore certify the fate of the two-thirds of phytoplankton that

Forecast of temperature increases between 2070 - 2100



Rising temperatures will accelerate ocean currents

The surface water circulation in our oceans is largely driven by the winds. In fact, scientific studies have so far focused on the effect of wind changes. The research pathway of water temperature variations has therefore received much less attention, whereas such changes could significantly influence ocean circulation in the context of global warming. Qihua Peng from the Scripps Institution of Oceanography at UC San Diego and her international team of researchers have been looking into this problem and sharing their findings in Science. They used simulations of the general ocean circulation and assessed their responses to variations in wind, temperature and salinity.

How do surface waters react to rising temperatures?

The researchers show that the effects of increased temperature are dominant on winds and salinity, and simulations indicate that higher temperature causes surface currents to accelerate significantly. This increase in the speed of surface currents would come from a large temperature difference between warm surface waters and cold waters at depth.

This study is important since we are in a context of anthropogenic warming which, unsurprisingly, will warm surface waters. Simulations show that in such a situation, 77% of the surface waters of all oceans will increase in speed.

A similar finding was made last year by Scripps scientists based on ocean and space observations of the Antarctic Circumpolar Current. This current that circles Antarctica is driven by winds coming from the west, and they discovered that this surface current is accelerating in response to global warming. Such large-scale ocean changes can affect the transport of nutrients that organisms feed on, as well as the microorganisms themselves.

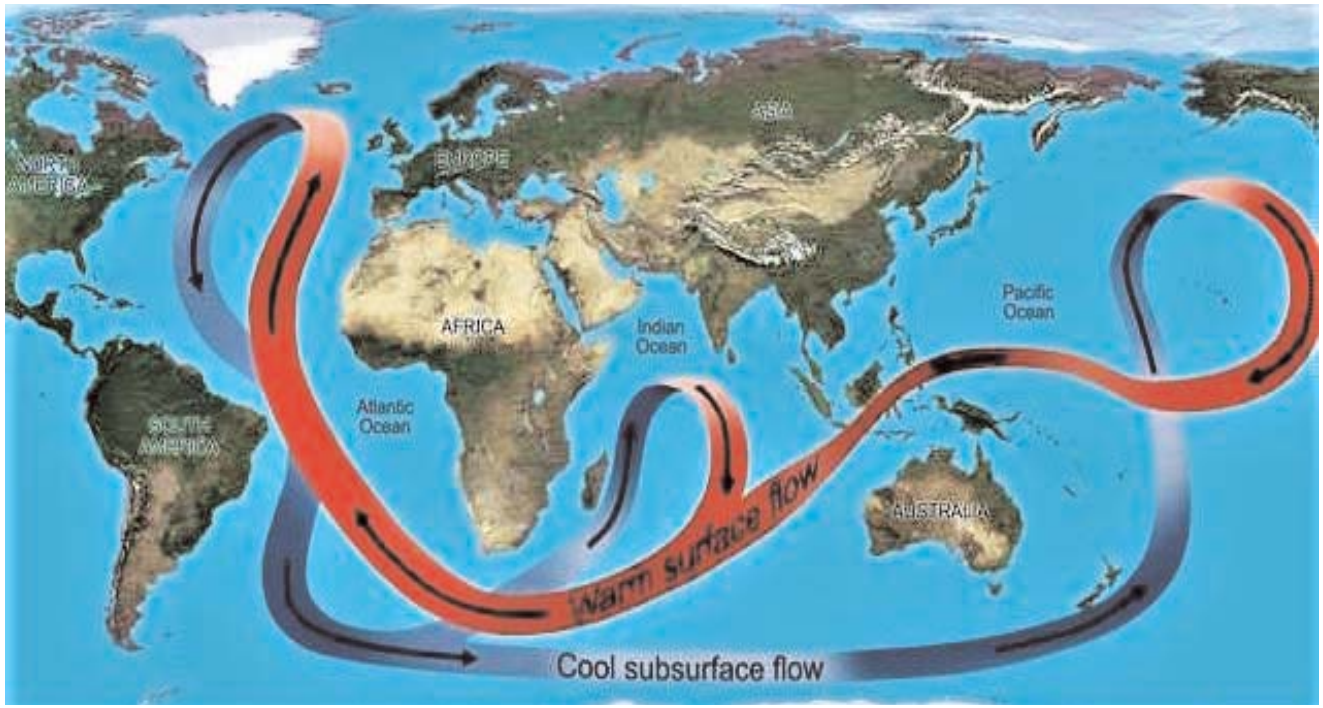


Illustration of the great loop followed by the circulation of the world ocean. Throughout the Atlantic Ocean, circulation carries warm waters (red arrows) northward near the surface and cold deep waters (blue arrows) southward. © NASA, JPL

Oceans: the carbon pump and the role of plankton

The oceans absorb a large part of the CO2 from the atmosphere, thanks to the carbon pump. In oceanography, we talk a lot about the carbon pump, but how does it work, what is its role?

Exchanges between the air (atmosphere) and the sea are permanent. On the one hand there are "carbon sources", areas of the ocean that naturally release CO2, and on the other, "carbon sinks", other areas that absorb it.

A physical pump

The "physical pump" limits the accumulation of carbon in the atmosphere. Warm tropical surface waters reach high latitudes where they cool. Carbon dioxide is more soluble in cold water, so it is absorbed by these waters before sinking with them to the depths. Part of this absorbed carbon is returned to the atmosphere, but much later, as these deep waters mix with surface ocean waters.

A biological pump

(Phyto)plankton is the main player in the oceanic "biological pump". Photosynthesis, which allows the growth and development of phytoplankton, consumes large quantities of CO2, the carbon of which is thus fixed in organisms. The food chain then does the rest: the phytoplankton is absorbed by the zooplankton. Faecal balls of zooplankton and dead phytoplankton migrate to great depths where part of the carbon ends up in sediments at the bottom of the oceans.

The abyssal depths of the oceans harbor much greater biodiversity than plankton and little-explored ecosystems harboring the richest fossil record on Earth. This is what researchers have been working on, alerting them to the role of deep marine ecosystems in the key process of the ocean carbon pump. At a time of climate change, oil exploitation and deep-sea mining, better knowledge of these environments would make it possible to protect a unique biodiversity. The largest biome on our planet is the ocean, which covers 71% of the Earth's surface with an average depth of 3,800 meters.

It is an integrated and continuous ecosystem, with extreme spatio-temporal dimensions that are difficult to access. However, it is necessary to measure it in its entirety to understand its functioning and its role in the Earth system. This involves in particular knowing the biodiversity of the ocean, and understanding how this biodiversity is structured in space and time, and interacts between the surface layers bathed in light and the deep, cold and dark sediments, where organic matter can be recycled by living organisms, or sequestered for millennia.

The role of ocean biodiversity in atmospheric carbon transfer and storage

Analyzes first show that abyssal marine sediments contain at least three times more biodiversity than masses of ocean water; this benthic diversity is very different (taxonomically) from that which constitutes plankton, and more structured in space, both globally and locally. And above all, two thirds of the DNA sequences (barcodes) discovered in the deep sediments do not correspond to any known sequence (taxonomically) in the world reference bases.

Comparison of the species richness of the ocean layers down to the bottom shows that a small proportion of planktonic taxa (especially the most abundant, but not necessarily those thought to be important for the biological carbon pump) reach the sediments.

The planktonic communities that sink to the bottom change little in terms of composition, and the planktonic biodiversity present in the sediments and revealed by DNA makes it possible to predict the variations in annual organic carbon fluxes from the surface of the ocean to the bottom. This last result demonstrates that biodiversity is a key factor in the transfer and storage of atmospheric carbon at the bottom of the ocean for millennia.

Coral reefs

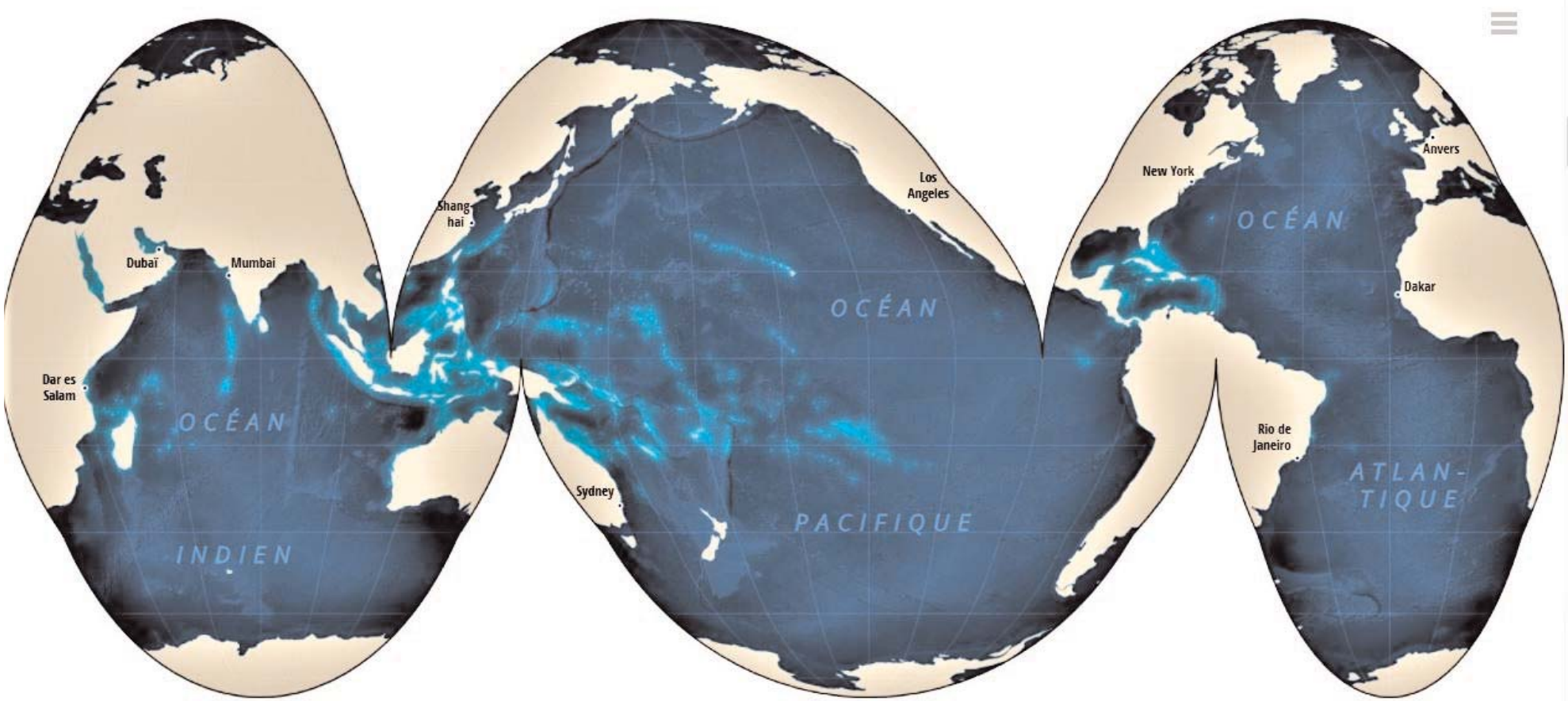
Rich in exceptional biodiversity, coral reefs provide food and habitat for many species of fish, as well as numerous benefits to tropical coasts and islands. These reefs also support the livelihoods and food security of more than half a billion people in more than 100 countries and are an essential asset for life above and below water.

Coral reefs in danger

The decline of coral reefs has been a concern for many years, and it continues at an alarming rate. Due to overfishing, pollution, invasive species, transportation and climate change, more than a third of coral species are now threatened with extinction.

Dead zones and coral reefs

Dead zones are areas in the oceans where the oxygen essential for marine life is insufficient. Nutrient runoff from chemical fertilizers is one of the main causes of this phenomenon. They lead to an over-abundance of microscopic algae which consumes all the oxygen and blocks the sunlight needed by other organisms. Dead zones can also result from other human-induced factors, such as sewage runoff and coastal urbanization, or from natural factors such as upwelling of oxygen-poor (a) coastal waters (targets 14.1 and 14.2 of the SDGs). This map shows the location of over 400 dead zones identified by researchers worldwide.

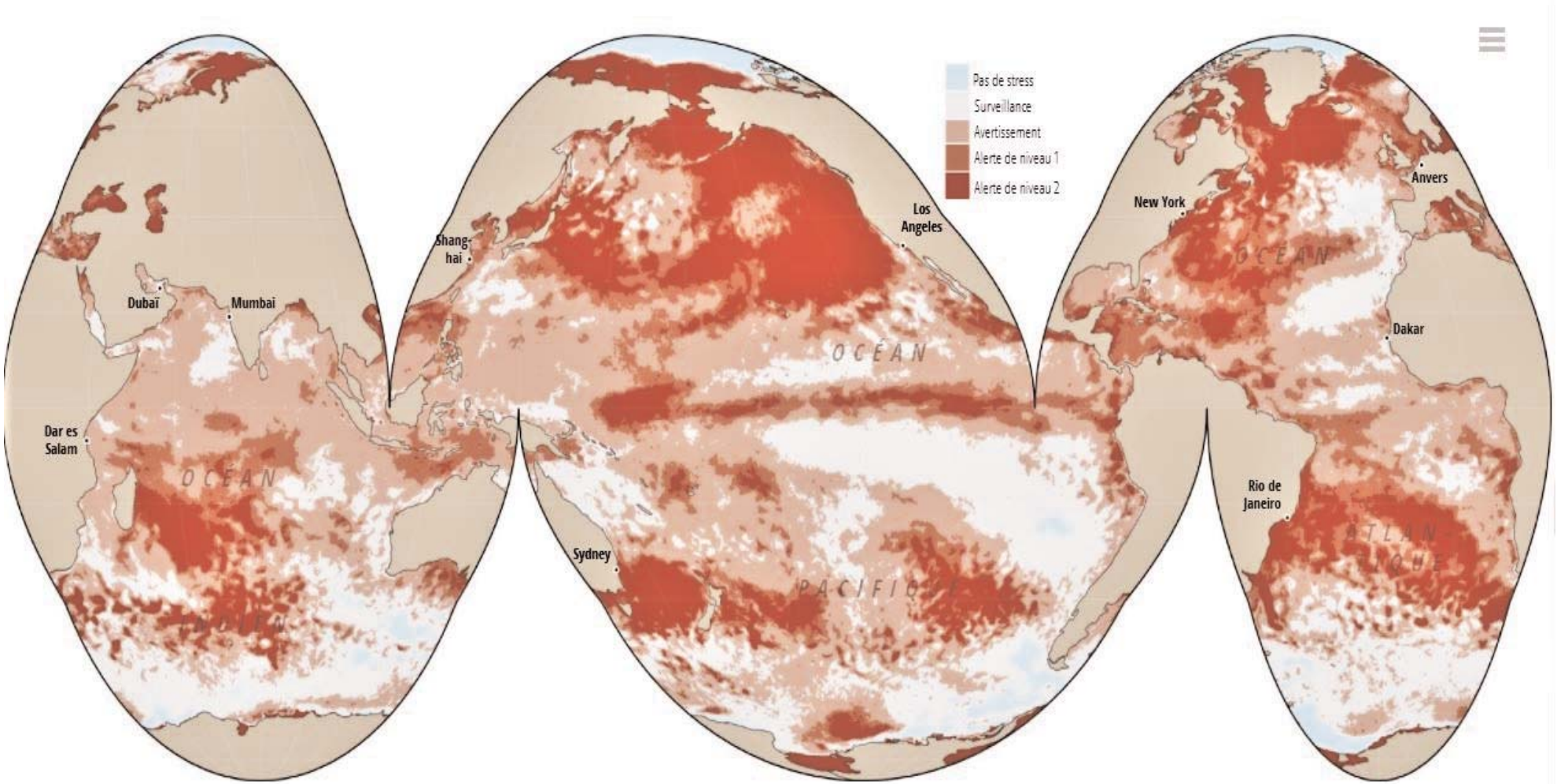


Source: UNEP-WCMC, WorldFish Centre, WRI, TNC (2018). Global distribution of coral reefs, compiled from multiple sources including the Millennium Coral Reef Mapping Project. Version 4.0, updated by UNEP-WCMC (data.unepwcmc.org/datasets/1)

In the tropics, many coral reefs lie near dead zones or are threatened by algal blooms caused by overfishing by grazing fish. It is likely that the extent of coral loss due to oxygen depletion in these areas is underestimated.

Coral bleaching

Coral reefs are also dying due to bleaching, when corals become discolored due to rising ocean temperatures. This phenomenon makes them more vulnerable to environmental hazards and more exposed to the risk of extinction. Massive bleaching caused by rising temperatures in the Caribbean and on the Great Barrier Reef in Australia has caused the death of many coral reefs.



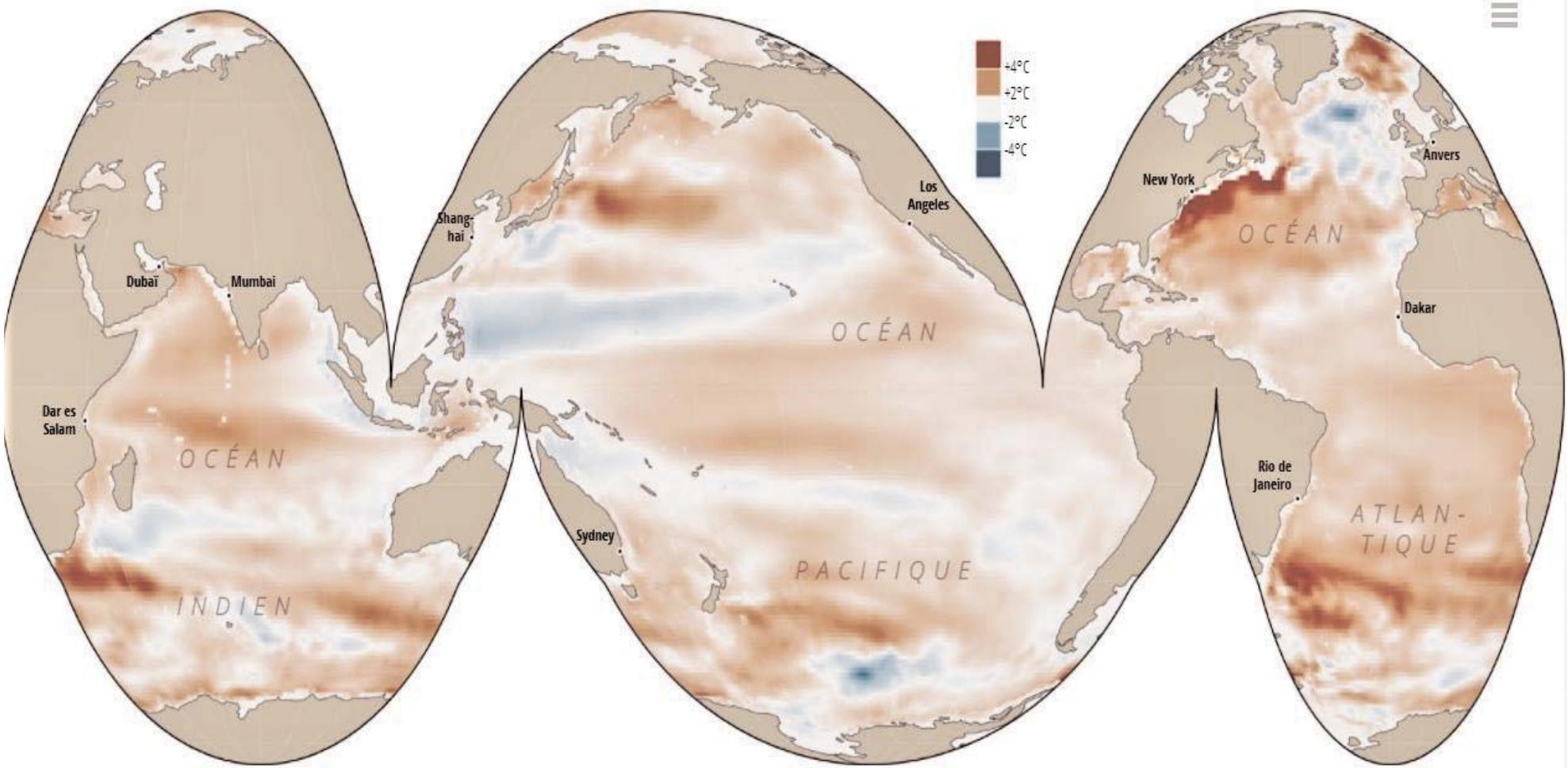
Source: NOAA Corral Reef Watch

Heat content of the oceans

The ocean is the greatest collector of solar energy on the planet. For some time, the increase in greenhouse gas concentrations has resulted in excess heat that does not leave the atmosphere, but remains stored in the oceans. The oceans have thus absorbed more than 90% of excess heat over the past 40 years.

Impact of climate change and human activity

Climate change has contributed to ocean acidification, which has increased by 30% since the 1900s. Rising concentrations of carbon dioxide in the atmosphere cause it to increase in seawater. carbon dioxide in the water increases the acidity of the oceans, which leads to the dissolution of the calcium carbonate they contain. However, corals and molluscs depend on calcium carbonate to form their shell or their skeleton, and its reduction can considerably reduce their ability to survive.

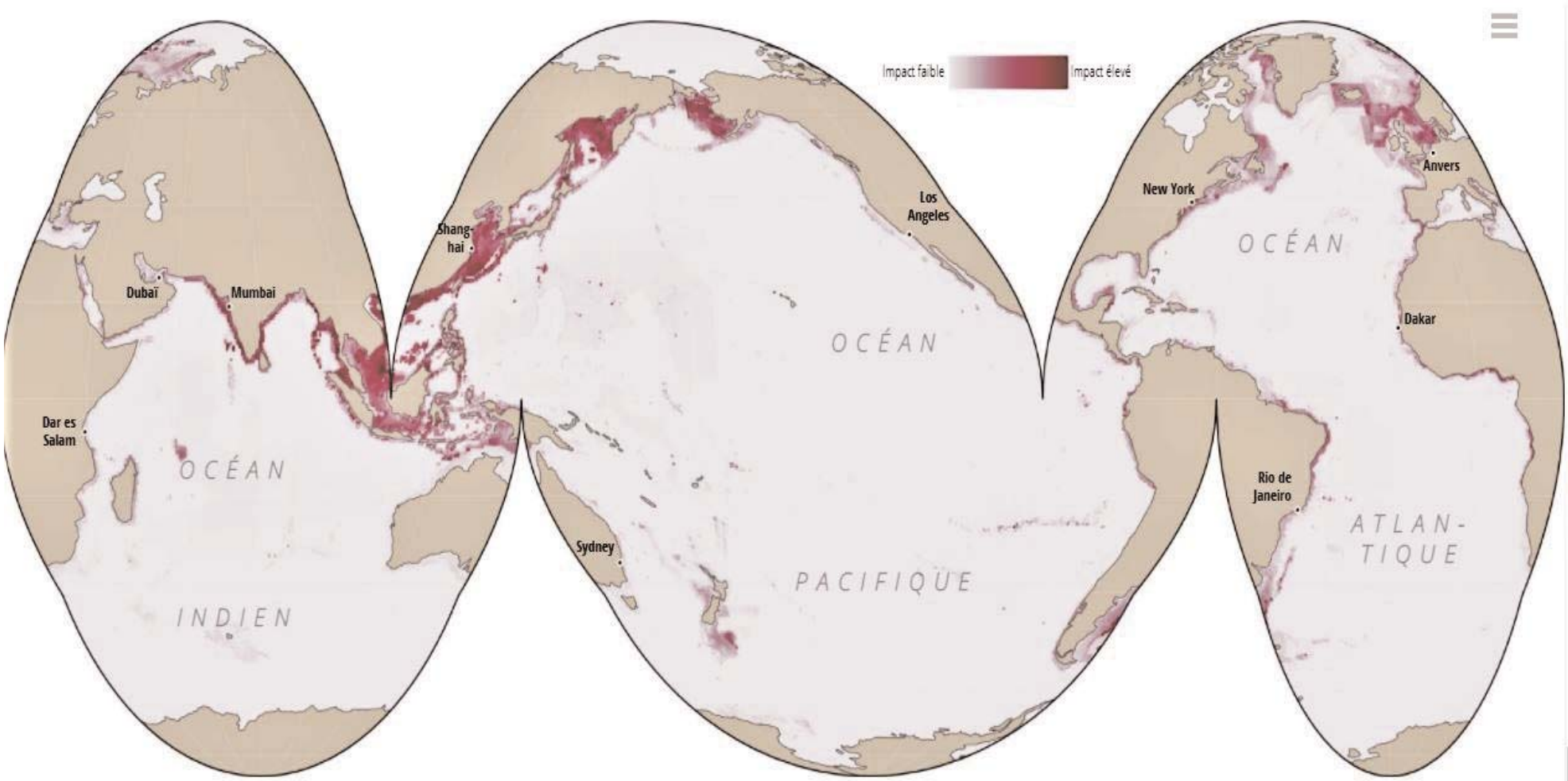


Note: Ocean heat content anomaly in 2019 relative to the 1981–2010 baseline

Source: Cheng et al. 2020 AAS

In 2019, the heat content of the oceans reached an all-time high. Beyond coral bleaching, the consequences of rising ocean temperatures are evident, from rising sea levels to increasing imbalances in fragile marine ecosystems. As ocean temperatures rise, marine species are under greater physiological stress, as their habitats warm and many now live near the maximum temperature at which they can survive. Increased exposure of marine life to climate change is likely to lead to more local extinctions and more rapid changes in the variety of species in the ocean.

To adapt to the increasing heat of the waters, marine species are already moving more towards cooler regions where the temperature better matches their needs. Conversely, areas where the water is warming are increasingly populated by species adapted to them, which changes the composition of the ecosystem.



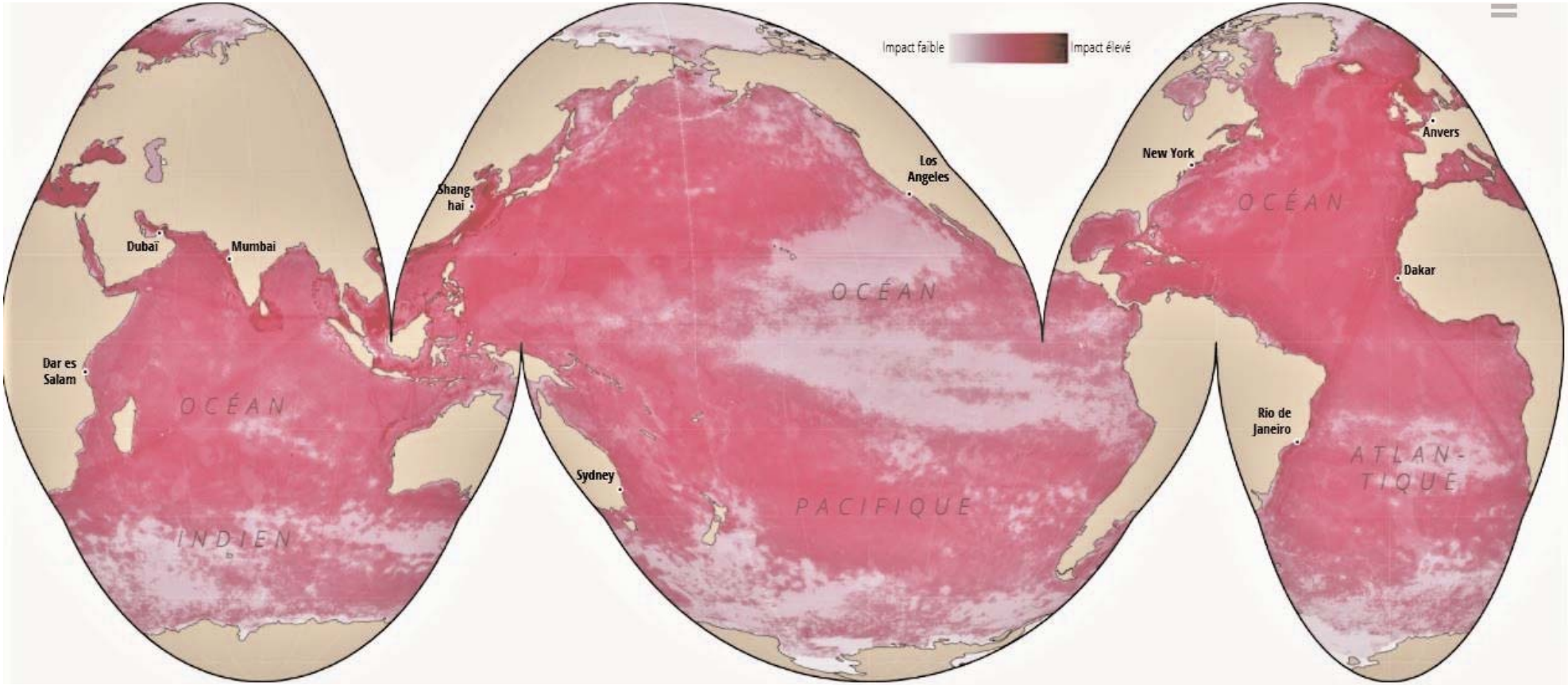
Source: Halpern, B., Frazier, M., Potapenko, J. et al. Spatial and temporal changes in cumulative human impacts on the world's ocean. Nat Commun 6, 7615 (2015)

To adapt to the increasing heat of the waters, marine species are already moving more towards cooler regions where the temperature better matches their needs. Conversely, areas where the water is warming are increasingly populated by species adapted to them, which changes the composition of the ecosystem.

Temperature is therefore a fundamental factor in the transformation of marine systems. Changes in fish populations have implications for fisheries. For example, in the northwest Atlantic Ocean, trawlers have had to move up to 400 kilometers further north to maintain the size and diversity of their catch.

Human Impact: Overfishing
Because they are destructive and non-selective, practices such as bottom trawling can damage seabed ecosystems and be responsible for a large amount of bycatch.

Human Impact: Navigation
Heavy ship traffic damages marine environments through the release of chemicals, transfer of invasive species, dumping of waste and various physical disturbances.

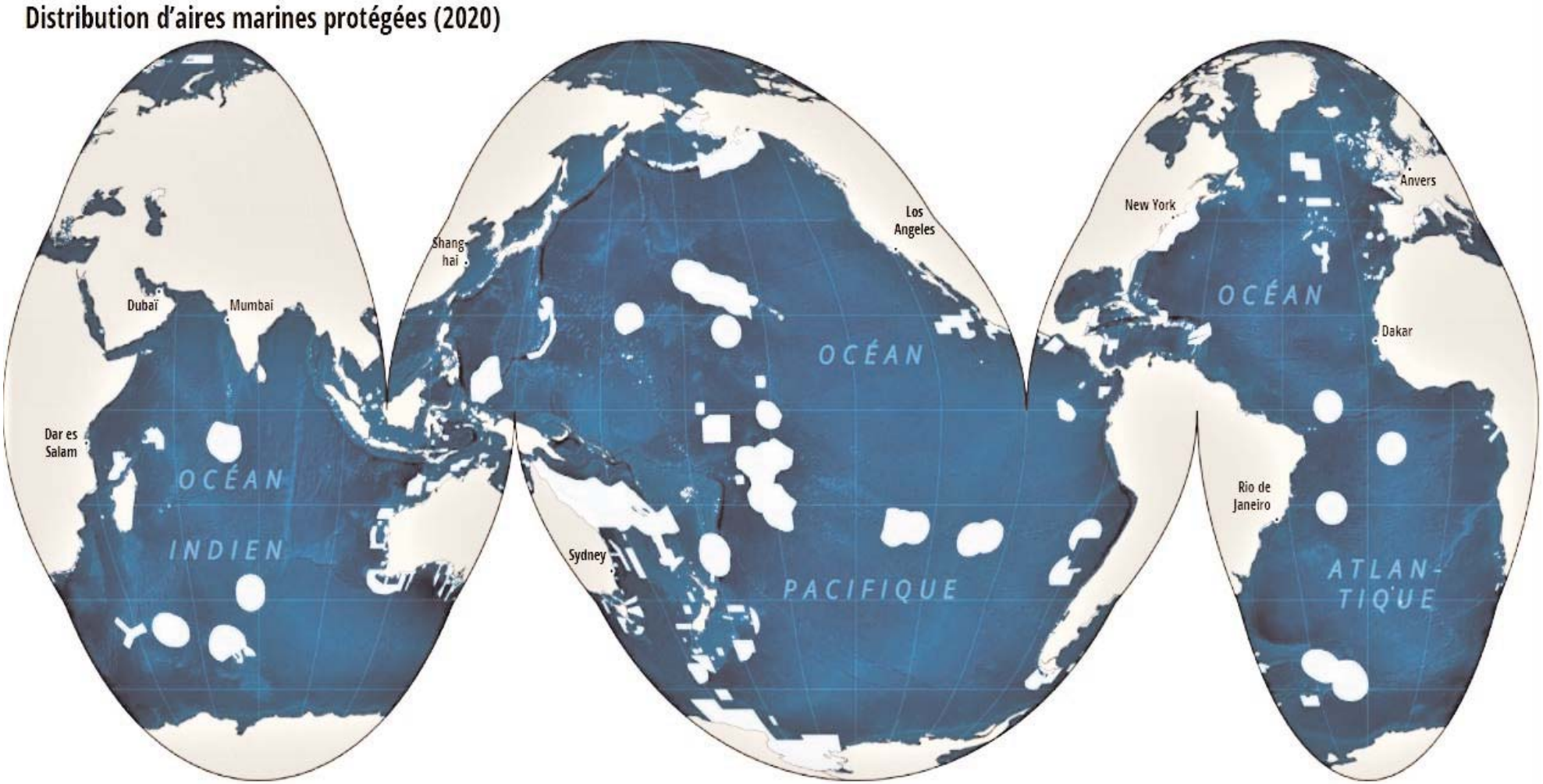


Impact of human activity: Cumulative
With nearly 98% of the world's oceans experiencing multiple stressors, the North Sea and the South and East China Seas are hotspots for the cumulative impact of human activities.

Marine protected areas

Marine protected areas have proven to be an effective means of safeguarding vulnerable species and ecosystems, conserving biodiversity, restoring ecosystem integrity, establishing clear guidelines and protecting feeding and breeding grounds for marine species (SDG target 14.5).

More than 16,000 protected areas have been created and cover 7.4% of the planet's oceans. Half of them do not allow fishing or other human activities. When properly adhered to, they have been shown to prevent coral loss and provide environmental and economic benefits.



Source: UNEP-WCMC and IUCN (2020) Marine Protected Planet [On-line], [March, 2020], Cambridge, UK: UNEP-WCMC and IUCN (www.protectedplanet.net/marine)

Glaciers

Glaciers are actually a huge mass of ice made up of a large amount of snow. Its formation takes a long time, up to 30,000 years for the largest of them.

The creation of a glacier occurs in the poles of the globe, where the temperatures are the lowest. In these places, the water undergoes a process of cooling and crystallization. The water molecules come together and harden, giving rise to ice crystals, which are deposited in layers on the surface of the Earth and can reach great thicknesses. The ice resulting from this natural activity has an extremely low melting temperature, down to hundreds of degrees below zero.

What are the types of glaciers?
In order to better study glaciers, differences appear according to their size and shape. There are two main categories:

The valley or alpine glacier
These are rivers of ice formed in the highest parts of mountain ranges, where snow accumulates. As the water flows down the mountain, it gradually turns into ice. This glacier is the width of a valley, and its rocky base can be hundreds of meters away.

In warmer mountain climates, a valley glacier may appear, it will be located only on the tops of high mountains. In colder regions, on the other hand, valley glaciers extend for several kilometres. If these glaciers are close to the coast, sometimes large chunks of glacier are released from them, giving rise to icebergs.

The continental glacier, or ice cap
It is much larger than the valley glacier. Their size is not due to greater precipitation, but to much slower melting.

The largest continental glaciers today cover much of Greenland and Antarctica. In these regions, the ice can reach a height of more than 3200 meters. They extend throughout the territory to the coast, where they also form icebergs.

What is the role of glaciers?
Because they concentrate almost 70% of the planet's fresh water, in solid form, glaciers are of capital importance for the maintenance of life on earth. The melting of glaciers, in addition to reducing the supply of fresh water, triggers a series of socio-environmental problems: rising ocean levels, floods, changes in ocean water temperature, reduction in biodiversity, etc. Thus, it is important to minimize this phenomenon of melting observed for several decades.

The glacier is a complex machine because it involves many physical variables that combine with each other; but at the same time, it is a convenient machine for approaching the climate, because it integrates these variables and gives information that can be more easily extrapolated to a larger space than that measured by a simple meteorological. In addition, the transfer function from the glacier to the climate once well known, we can build with images or old documents representing the glaciers in phases of extension different from the current climatic scenarios for the past, which are then "reconstructed" indirectly. The glacier is therefore a good "proxy" of the climate, as paleoclimatologists say.

In fact, the signal given to us by the glacier through these variations in volume (we speak rather of the mass balance) that we measure each year, sometimes each month, it must be analyzed to determine what are the climatic variables involved in this evolution, air temperature, precipitation, radiative fluxes, etc...

Glaciers are also important for the planet's albedo. This index represents the fraction of solar energy reflected outwards by the atmosphere and the earth's surface. This solar flux reflected by the earth's surface plays an important role in the planet's climate. Indeed, the ice reflects the light rays arriving on Earth, since its albedo is high.

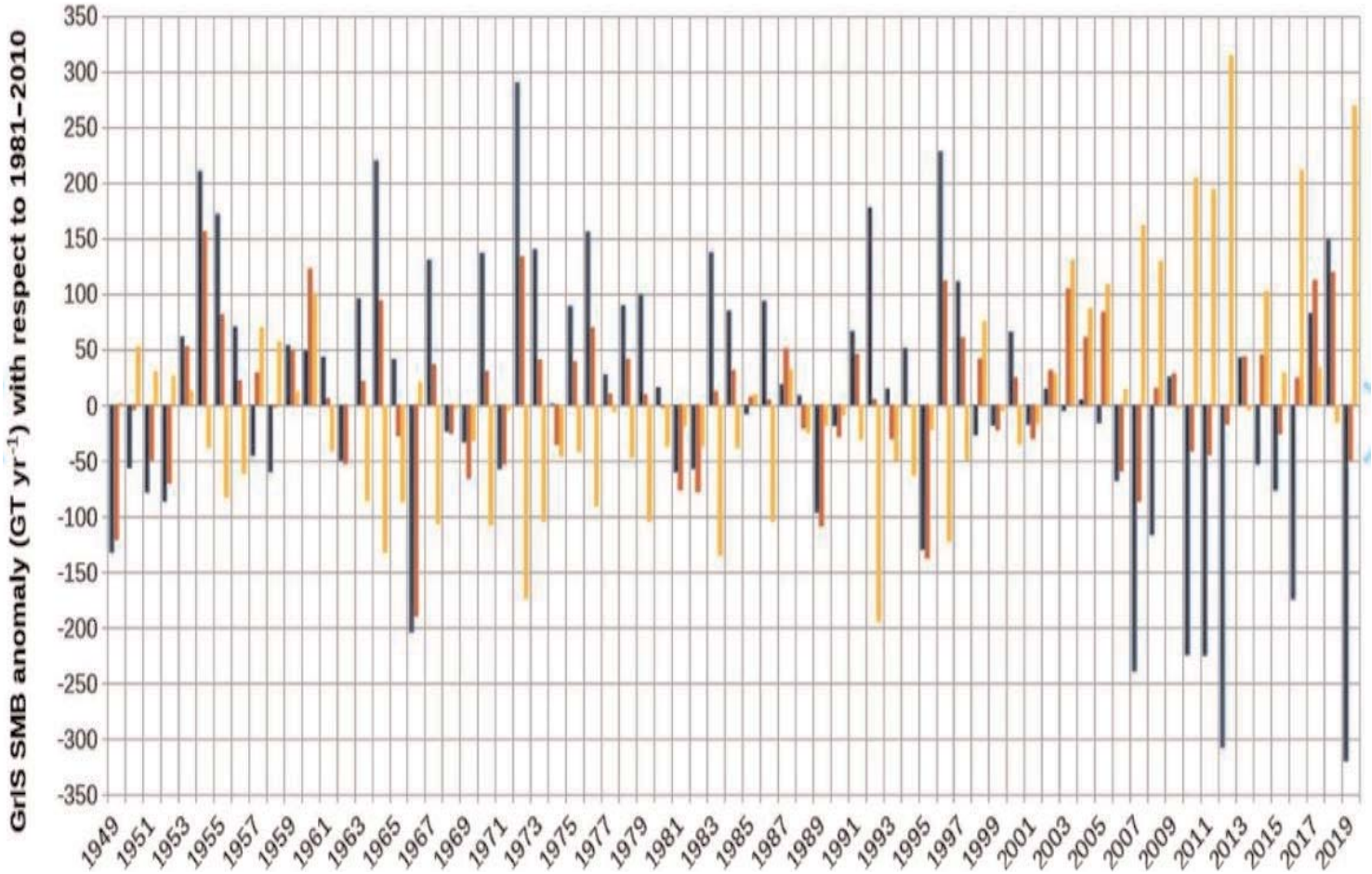
The melting of glaciers therefore causes a drop in the global terrestrial albedo. The energy that was previously sent into space will be transformed into heat and contribute to the increase in temperature.

Finally, glaciers contain particles of air and water that were formed several thousand years ago. Their study by scientists makes it possible to advance our understanding of our planet and climate change.

The role of glaciers in sea level variation has long been underestimated. It seems, however, that they are as much responsible for the rise in sea level as the polar ice caps.

Melting ice would deplete drinking water resources.

The melting of ice caps and glaciers is accelerating with the collateral damage of depleting the fresh water resources on which millions of people depend. "Freshwater resources are actually shrinking faster every year. This will increase the risk of water scarcity and water conflicts in many parts of the world."



In 2019, the amount of surface ice lost since records began in 1948 is the second largest amount after 2012. In contrast, the surface mass balance (SMB) is the lowest on record. Here, a graph showing, in red, the snowfall, in yellow, the melting of the ice and in blue, the SMB with the average of the period 1981-2010 as a reference. © Tedesco et al.

In seven regions of the world - which are Alaska, the Arctic Archipelago, the Southern Andes, the Himalayan region, the Russian Arctic, Iceland and the Norwegian archipelago of Svalbard -, indeed, the melting of ice caps and glaciers is accelerating.
The share of glaciers in the rise in sea level remains debated, in particular because it could only be estimated until now from a limited number of glaciers monitored in the field. An international team offers a finer estimate of their mass loss between 2003 and 2009 thanks to observations from two satellite missions (Grace and IceSat). This work indicates that glaciers are responsible for 30% of the rise in sea level for this period, thus equaling the Antarctic and Greenland ice caps combined.

The contribution of glaciers to sea level rise is traditionally estimated by extrapolating field measurements of the glacier mass balance, measurements limited for logistical reasons to a few dozen glaciers on the surface of the globe, monitored for five or six decades. But it remains to be demonstrated that this reduced sample of glaciers is representative of all the 200,000 glaciers on the planet. For a region such as the Himalayas that is difficult to access, recent work by French teams has shown that the infrequent field measurements seem to overestimate the mass losses of the glaciers.

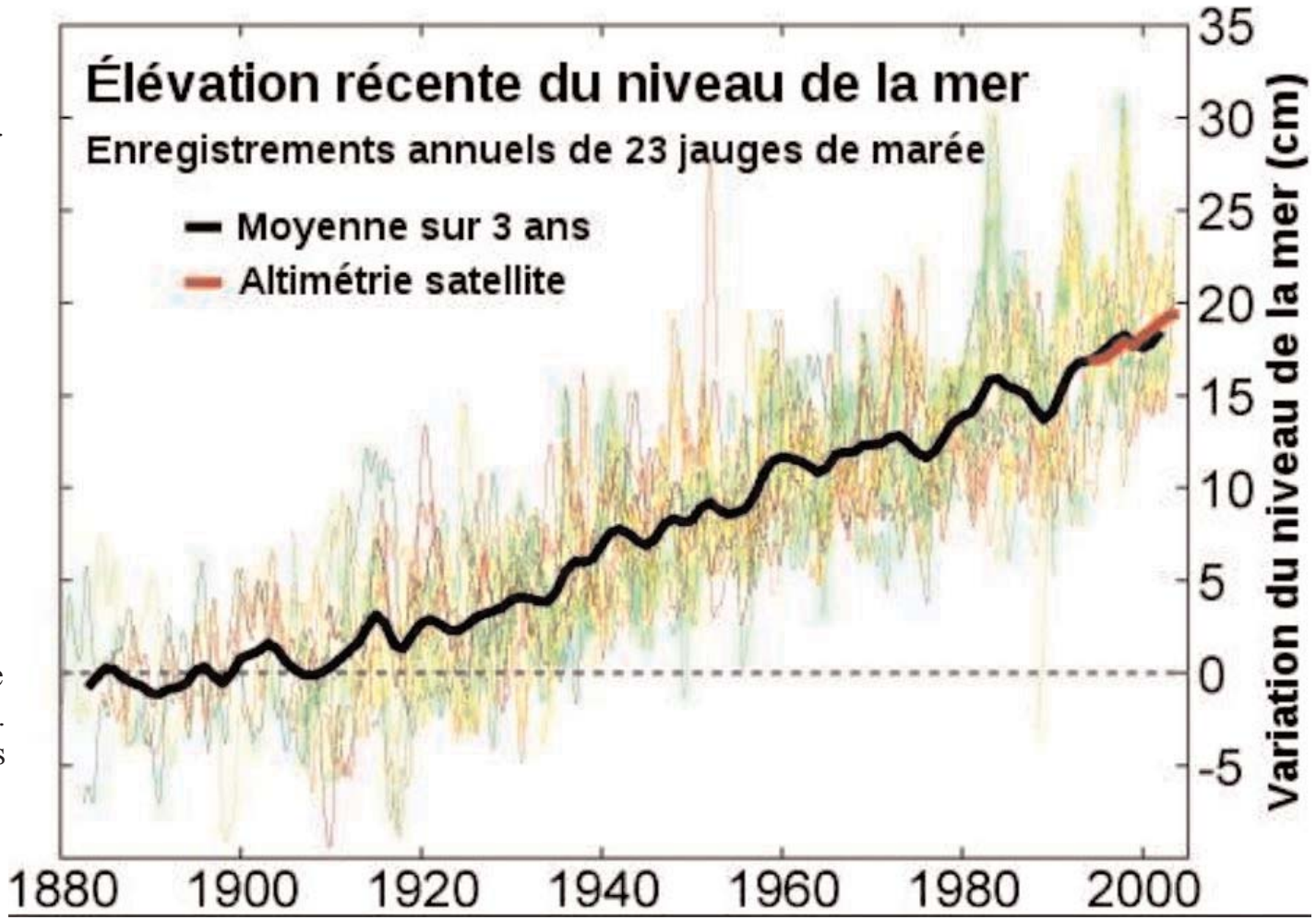
Ice losses in all regions of the globe

All over the world, glaciers are melting as a result of anthropogenic global warming. But the extent of the phenomenon remained to be clarified. Today, researchers assure that they lose almost 300 billion tons of ice every year. And that the pace of this melting has significantly accelerated over the past twenty years. Contributing substantially to sea level rise.

Almost everywhere on the planet, glaciers are melting today at a record and accelerating rate. Under the effect of anthropogenic global warming.

The period 2003-2009 saw two satellites cohabiting in orbit (IceSat and Grace) which make it possible to estimate ice loss for the main glaciated regions of the globe, independently of ground readings. The measurements of these two satellites agree on all the regions where the surfaces covered by glaciers are significant. The regions that contribute the most to sea level rise are the Canadian Arctic, Alaska, the glaciers peripheral to the Greenland ice cap and Patagonia.

On the other hand, the glaciers on the periphery (but distinct) of the Antarctic ice cap, although they occupy a vast area (133,000 km2, or 18% of the total glaciers) have experienced rather moderate losses during these six years. For regions where freeze-up is low (Alps, Norway, Western Canada), the data from these two satellites are poorly resolved and the field data remains the most reliable. Although there is strong geographical variability, all regions of the globe are recording losses.



Scientists are worried: the 3rd largest ice reserve in the world is collapsing.

Sometimes nicknamed "the third pole", or "the water tower of Asia", the center of the Tibetan plateau is the third largest reserve of ice after Antarctica and the Arctic. But because of global warming, researchers predict a radical change in the situation in the years to come. It's the climate crisis you haven't heard of.

This third pole supplies water to nearly two billion people. With almost two million square kilometres, the high Tibetan plateau located north of the Himalayas is sometimes nicknamed the water tower of Asia, or even the third pole, because of the quantity of ice it contains. But, as we have already known for years, it is melting faster and faster. Between the years 2000 and 2018, the total mass of glaciers fell from 340 gigatonnes to 166 gigatonnes, a decrease of more than 50%!
In recent decades, they have lost ice ten times faster than average since their last major expansion during the Little Ice Age between 400 and 700 years ago. a reconstruction of nearly 15,000 Himalayan glaciers. While at their peak they covered an area of some 28,000 square kilometres, today they already cover only about 19,600 square kilometres. That is a loss of ice of no less than 40% in area. Since the 1970s, a retreat and a thinning of the snow cover have already been observed. The phenomenon is aggravated by the pollution coming from the plains of India which deposits black dust on the glaciers, accelerating their melting. At the same time, they also lost in volume, dropping from 596 cubic kilometers to just 309 cubic kilometers. A loss equivalent to all the ice of the Alps, the Caucasus and Scandinavia combined.

In question, global warming, of course: its effects are felt all the more at altitude. Temperatures are rising, and melting the glaciers. But it's not that simple, as a study published in the journal Nature reviews explains. earth & environment , which reports on the current situation and its possible evolution.

Indeed, if the base is indeed a melting of the stored ice, this melting results in a number of consequences: first of all, the change in ice-liquid phase creates, according to the researchers, a "south-north disparity due to to the spatio-temporal interaction between the westerly winds and the Indian monsoon." Specifically, this means that the atmospheric circulations changed due to an increase in the proportion of liquid water, and then changed the distribution water resources by region.

The consequences are likely to vary with the acceleration of warming.

If this melting of the Himalayan glaciers has already caused a rise in sea level of around 1 millimetre, it is above all for the supply of water and energy to the hundreds of millions of inhabitants of the region that the scientists worry. Because the acceleration of the phenomenon will have important implications on the main river systems of the Himalayas. The inhabitants of the region are already seeing changes that seem to be accelerating.
More precisely, the water flows more and more towards the north, and less and less towards the south. This imbalance tends to increase, and in the long term, the exoreic basins of the south - which plunge towards the sea - risk drying up, and the endorheic basins - which are closed - risk ending up submerged. Global warming should amplify this imbalance, feeding even more "the basins of the Yellow and Yangtze rivers" and, conversely, causing a shortage in "the basins of the Indus and the Amu-Daria". For the Indus, in particular, the researchers are concerned because, on the banks of the river, there are many agricultural areas that require significant irrigation.

The severe consequences of this melting will affect the 250 million inhabitants of these mountains and the 1.65 billion who live in the river basins downstream. The HKH glaciers thus feed ten of the most important river systems in the world, including the Ganges, Indus, Yellow, Mekong and Irrawaddy.

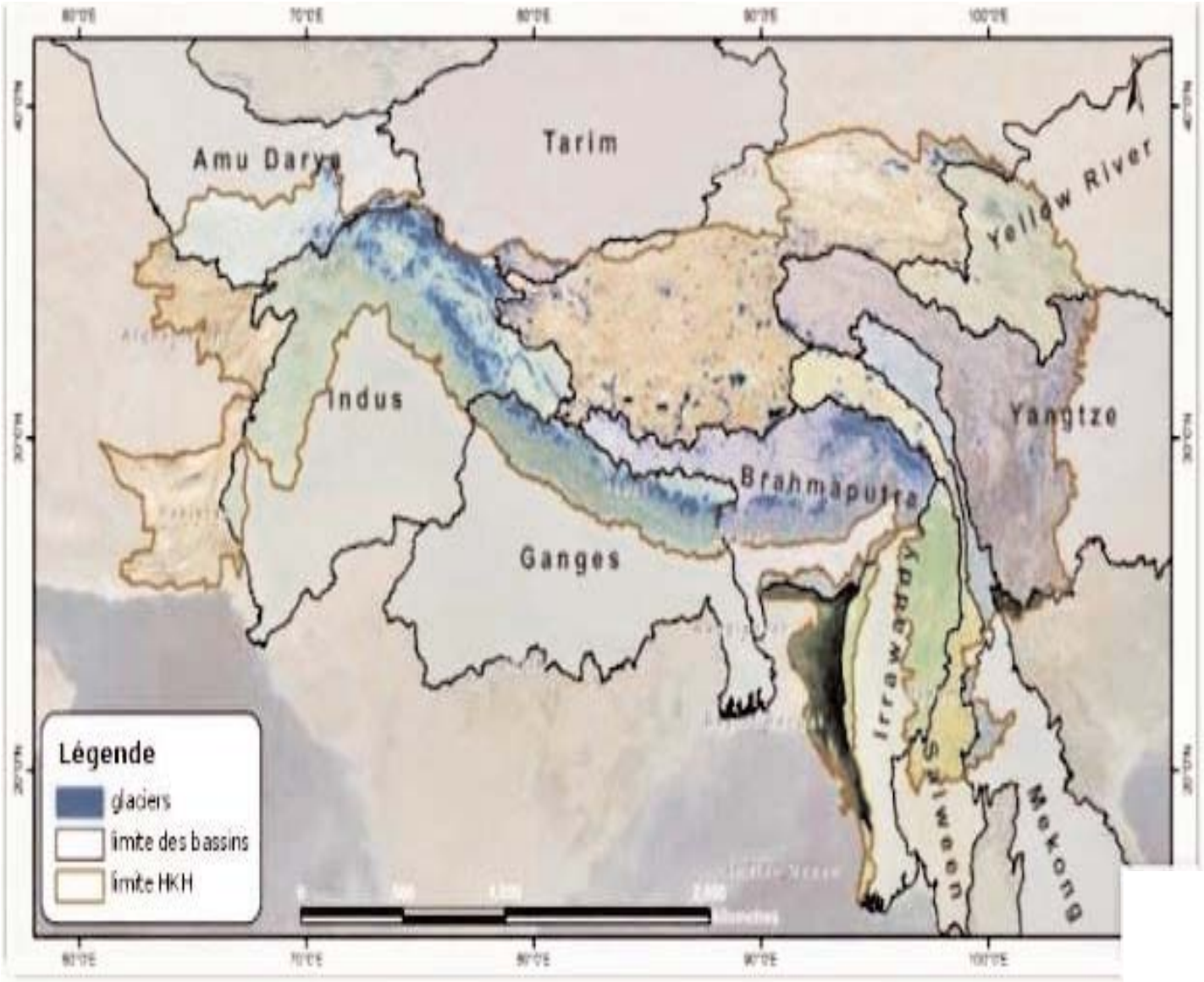
"An increase in the number and size of glacial lakes will lead to an influx of water into major rivers, which could cause flooding and crop destruction," the study warns. The increased flow of the Ganges and Brahmaputra will also force changes in agriculture. Landslides and more frequent flooding "endanger more than a billion people", warns Icimod . In total, millions of people are affected who could well run out of water soon.

Between 2000 and 2004, the world's glaciers lost some 227 billion tonnes each year. Between 2015 and 2019, they melted about 298 billion tons of ice each year. In other words, while in 2000, the glaciers thinned by 36 centimeters, they lost no less than 69 centimeters in 2019. Their global mass has, for its part, fallen by an average of 267 billion tons per year. year since 2000. This is more than the ice cap of Greenland or that of Antarctica.

Fifty-four thousand glaciers in the Himalayas

The first object of the work of this organization was to identify the glaciers of the region. They are 54,000 in number (ie 30% of the world total) and cover an area of 60,000 km² for approximately 6,000 km3 of ice. But among this accumulation of glaciers - which is why the region is called the third pole - only ten have been studied precisely, and it is on these that the synthesis of the Icimod focused.

These publications of the International Center for Integrated Mountain Development (Icimod) constitute the most complete synthesis of the state of the glaciers and the snowpack on the peaks of the Himalayas, in the Hindu region. Kush -Himalaya, which encompasses the majority of Himalayan peaks.



These values, the researchers hold them from the analysis of half a million images taken by the Terra satellite of nearly 220,000 glaciers. Using two cameras, since 2000 it has regularly acquired pairs of images of the Earth's surface. And these images have allowed scientists to create digital models of glacier elevation with unparalleled spatial and temporal precision.

In total, glacier mass losses amounted to 260 gigatons per year on average between 2003 and 2009, which is equivalent to 0.72 mm per year of sea level rise. During this same period, the sea level rose by about 2.5 mm per year. These new satellite measurements show that the extrapolation of field measurements to all the glaciers of the globe leads in most regions to an overestimation of losses for the period 2003-2009. But this period remains short from the climatic point of view.

Melting Central Asian glaciers threaten freshwater resources

The glaciers of the Tian Mountains, in Central Asia, have lost 27% of their mass and 18% of their surface over the past fifty years. The snow and ice that melt from these glaciers are essential to the water supply of many countries.

The Tian Mountains are the largest mountain range in Central Asia. Forming magnificent landscapes of ice, their glaciers play an important role in the water cycle of different countries: Kazakhstan, Kyrgyzstan, Uzbekistan and parts of China, where populations are very dependent on water. from melting snow and ice for their water supply.

Glaciers are real reservoirs that store water in the form of ice for decades and return water from winter precipitation during the summer months through melting. The phenomenon is particularly important for arid regions which receive almost no precipitation during certain months. Glaciers also balance water volumes between wet and dry years.

The retreat of the glacier accelerated between the 1970s and 1980s. The study shows that the rise in temperature, especially in summer, is a key factor in the evolution of the glacier. "As the winter months in the region are very dry and the mountains high, most snowfall on glaciers occurs in the summer. This means that higher temperature helps to both increase melting and reduce glacier feed."

Greenland: the melting of the ice in 2019 betrays profound changes that were not expected

In 2019, several billion tons of ice were lost. In question, not only the rise in temperatures, but also unusual atmospheric conditions, reveal researchers. Conditions that could become more and more frequent under the effect of global warming. Greenland is the second largest mass of ice on Earth. A blanket several kilometers thick. Who experienced in 2019, a significant imbalance. A loss of 600 billion tons. Enough to raise sea levels by 1.5 millimeters, or 40% of the total rise recorded last year. Yet in 2019, what the researchers call Greenland's surface mass balance (SMB) -- snowfall versus melting ice -- stands at 50 billion tonnes. The volume of surface ice gained over the year by the ice sheet. A number that seems positive. But which still marks a fall of 320 billion tonnes below its average for the period 1981-2010. And that is not enough to compensate for the losses due to the formation of icebergs. Far from there...

A study published this week by researchers at Columbia University (United States) looks more specifically at the causes of this phenomenon. Rising temperatures are not the only culprit. Unusual anticyclonic conditions would indeed be responsible for more than half of the ice lost in Greenland in 2019. These conditions have, for example, prevented the formation of clouds over the south of the ice sheet. And allowed the sun's rays to directly reach the ice to melt it more efficiently. All the more urgently as the total thaw in Greenland could raise sea levels by no less than seven metres!

GLACIAL LAKES

For weeks, India, but also Pakistan, have been hit by a wave of stifling heat. The consequence, probably not yet sufficiently known, is the sudden rupture of glacial lakes. One of them occurred this Saturday, May 7, 2022. That of a lake that had formed on the Shisper glacier . The subsequent massive flooding partially destroyed the Karakoram Highway Bridge. But fortunately, there is no other damage to deplore.

Shisper Glacier Lake -- such lakes can form at the foot of, on, in or even under a glacier from melted ice -- appeared this year no less than a month earlier. than usual. The heat that has settled over the region has caused the water to rise to an unusual level. More than 40% over the last twenty days. For a total level of 15% higher than that recorded over the past three years.
The most worrying thing is that other glacial lakes of the same type - some estimate their number at no less than 33 - could suffer the same fate in the coming days. In the regions most at risk, populations have been relocated as a preventive measure.

Among the possibilities of adaptations - which do not solve the fundamental problem of global warming, but preserve the populations as much as possible from its effects: the drainage of glacial lakes. Like what was done under the Tête Rousse glacier in the Alps. A tunnel to evacuate pockets of water. And to contain the risk a little more, titanic pumping operations.

ARCTIC AND ANTARCTIC

After the Arctic, the melting of the Antarctic sea ice is becoming a source of concern. It reached at the end of the austral summer, in February, its lowest level for 44 years, according to the observations of a group of researchers published on Tuesday.

The natural cycle of the pack ice (the ice that floats on the ocean) is that it melts in summer and re-forms in winter, with satellites recording very precisely since 1978 the areas covered in each season, from year to year. . In the long term, melting is rapid in Greenland and the Arctic, but conversely, in Antarctica, the trend was modestly increasing, despite significant annual and regional variations.

Antarctica is surrounded by a huge ice floe. It extends during each Austral winter and is greatly reduced in summer (January-February-March). This year, high temperatures and strong foehn winds caused record melting. Antarctic sea ice reached a new low in February 2022.

This thin layer of sea ice does not influence the sea level. However, it is very important for the Earth's climate. The whiteness of the sea ice reflects the rays of the sun in summer, while the dark surface of the sea, like a black coat, absorbs much more heat.

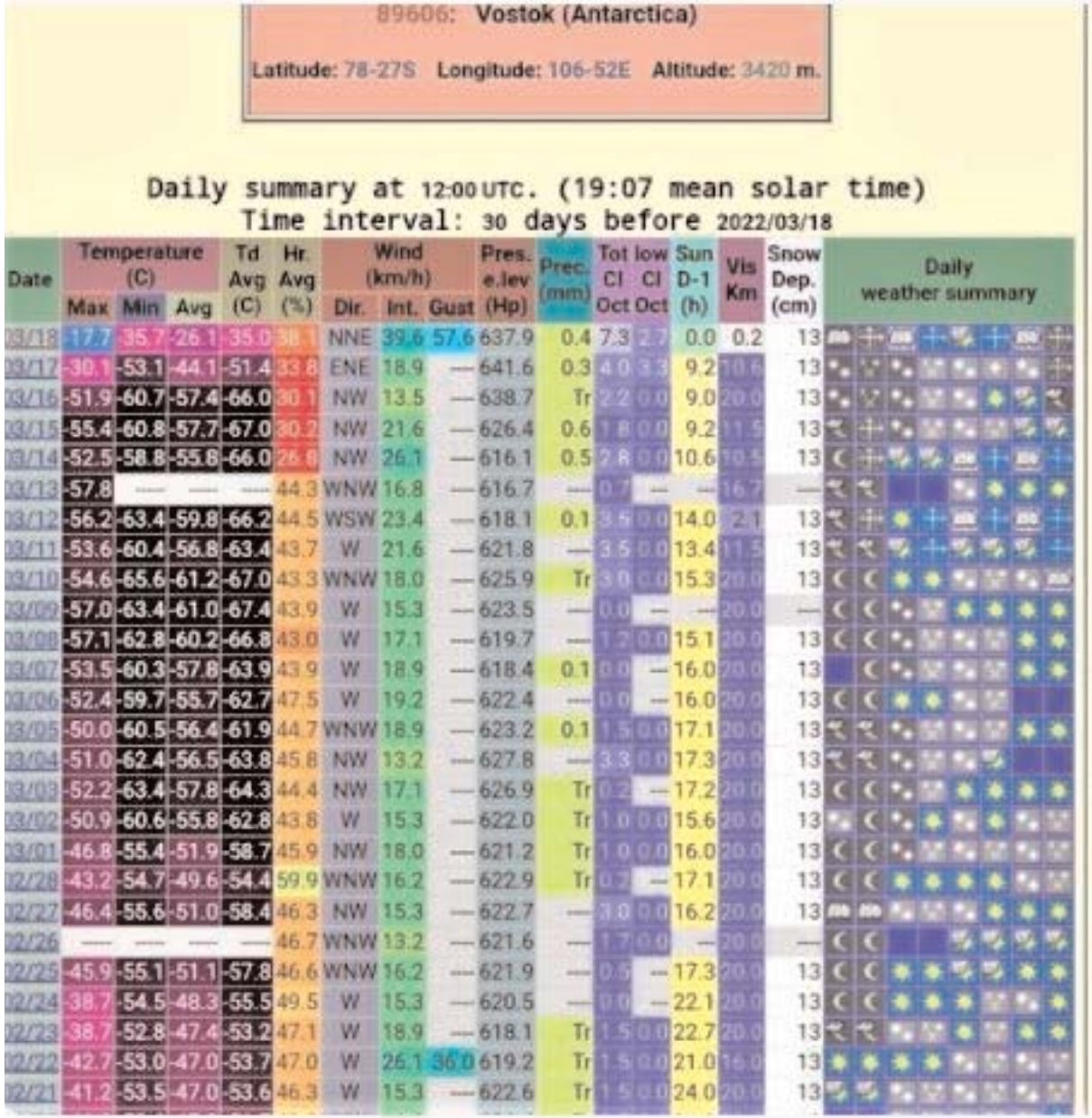
The Antarctic sea ice has been greatly reduced during the years 2016-2019. During the 2018-2019 austral summer, it barely occupied half the usual area. The other half melted or was shattered, disintegrated by violent storms. That's a big difference, the Earth appears darker, and absorbs more sunlight.

This rapid, spectacular melting represented a loss as great as the area lost in the Arctic in thirty years. It may have played an important role in the rapid warming and record temperatures of the Earth during those years .

The sea ice had reformed in 2020, and land temperatures have stabilized, but this year it has melted more than ever before. Areas of older ice, present for several years and thicker, are covered with puddles of water and weakened. They could give way quickly.

This year, the Antarctic sea ice has therefore plunged and was measured at 1.9 million square kilometers on February 25, a record low since records began in 1978, reports a group of researchers mainly

Température maximale -17,7°C à Vostok, un 18 mars ! Le précédent record mensuel est pulvérisé de près de 15°C.
Il s'agit selon moi d'un événement climatologique d'ampleur aussi extraordinaire que la vague de chaleur intense centrée sur la Colombie Britannique en juin 2021.



89606: **Vostok (Antarctica)**

Latitude: 78-27S Longitude: 106-52E Altitude: 3420 m.

Daily summary at 12:00 UTC. (19:07 mean solar time)
Time interval: 30 days before 2022/03/18

Date	Temperature (C) Max	Min	Avg	Td Avg (C)	Hr. Avg (%)	Wind (km/h) Dir.	Int.	Gust	Pres. e.lev (Hp)	Prec. (mm)	Tot Cl Oct	low Cl Oct	Sun D-1 (h)	Vis Km	Snow Dep. (cm)	Daily weather summary
03/18	-17.7	-35.7	-26.1	-35.0	38.1	NNE	39.6	57.6	637.9	0.4	7.3	2.7	0.0	0.2	13	
03/17	-30.1	-53.1	-44.1	-51.4	33.8	ENE	18.9	—	641.6	0.3	4.0	3.3	9.2	10.0	13	
03/16	-51.9	-60.7	-57.4	-66.0	30.1	NW	13.5	—	638.7	Tr	2.2	0.0	9.0	20.0	13	
03/15	-55.4	-60.8	-57.7	-67.0	30.2	NW	21.6	—	626.4	0.6	1.8	0.0	9.2	11.5	13	
03/14	-52.5	-58.8	-55.8	-66.0	26.6	NW	26.1	—	616.1	0.5	2.8	0.0	10.6	10.5	13	
03/13	-57.8	—	—	—	44.3	WNW	16.8	—	616.7	—	0.7	—	—	16.7	—	
03/12	-56.2	-63.4	-59.8	-66.2	44.5	WSW	23.4	—	618.1	0.1	3.5	0.0	14.0	2.1	13	
03/11	-53.6	-60.4	-56.8	-63.4	43.7	W	21.6	—	621.8	—	3.5	0.0	13.4	11.5	13	
03/10	-54.6	-65.6	-61.2	-67.0	43.3	WNW	18.0	—	625.9	Tr	3.0	0.0	15.3	20.0	13	
03/09	-57.0	-63.4	-61.0	-67.4	43.9	W	15.3	—	623.5	—	0.0	—	—	20.0	—	
03/08	-57.1	-62.8	-60.2	-66.8	43.0	W	17.1	—	619.7	—	1.2	0.0	15.1	20.0	13	
03/07	-53.5	-60.3	-57.8	-63.9	43.9	W	18.9	—	618.4	0.1	0.0	—	16.0	20.0	13	
03/06	-52.4	-59.7	-55.7	-62.7	47.5	W	19.2	—	622.4	—	0.0	—	16.0	20.0	13	
03/05	-50.0	-60.5	-56.4	-61.9	44.7	WNW	18.9	—	623.2	0.1	1.5	0.0	17.1	20.0	13	
03/04	-51.0	-62.4	-56.5	-63.8	45.8	NW	13.2	—	627.8	—	3.3	0.0	17.3	20.0	13	
03/03	-52.2	-63.4	-57.8	-64.3	44.4	NW	17.1	—	626.9	Tr	0.2	—	17.2	20.0	13	
03/02	-50.9	-60.6	-55.8	-62.8	43.8	W	15.3	—	622.0	Tr	1.0	0.0	15.6	20.0	13	
03/01	-46.8	-55.4	-51.9	-58.7	45.9	NW	18.0	—	621.2	Tr	1.0	0.0	16.0	20.0	13	
02/28	-43.2	-54.7	-49.6	-54.4	59.9	WNW	16.2	—	622.9	Tr	0.7	—	17.1	20.0	13	
02/27	-46.4	-55.6	-51.0	-58.4	46.3	NW	15.3	—	622.7	—	3.0	0.0	16.2	20.0	13	
02/26	—	—	—	—	46.7	WNW	13.2	—	621.6	—	1.7	0.0	—	20.0	—	
02/25	-45.9	-55.1	-51.1	-57.8	46.6	WNW	16.2	—	621.9	—	0.5	—	17.3	20.0	13	
02/24	-38.7	-54.5	-48.3	-55.5	49.5	W	15.3	—	620.5	—	0.0	—	22.1	20.0	13	
02/23	-38.7	-52.8	-47.4	-53.2	47.1	W	18.9	—	618.1	Tr	1.5	0.0	22.7	20.0	13	
02/22	-42.7	-53.0	-47.0	-53.7	47.0	W	26.1	36.0	619.2	Tr	1.5	0.0	21.0	16.0	13	
02/21	-41.2	-53.5	-47.0	-53.6	46.3	W	15.3	—	622.6	Tr	1.5	0.0	24.0	20.0	13	

from Sun University. Yat-sen in Canton, in an article published in the journal Advances in Atmospheric Sciences. Five years after a previous record drop of just over 2 million km2 in 2017, the area covered by sea ice has fallen below the 2 million km2 mark for the first time. That is 30% less than the average over three decades between 1981 and 2010.

A melt linked to "thermodynamics"

This study confirms the observations of the American National Snow and Ice Data Center announced a few weeks ago, just before the arrival of an unprecedented heat wave in eastern Antarctica in March.

According to the authors of the study published on Tuesday, in the western Amundsen Sea and in the eastern Ross Sea, the disappearance of the pack ice was complete by February 25. More generally, the sea ice began to retreat earlier in the year, from the beginning of September, and compared to 2017, it recorded a late recovery, at the end of February.

The melting is linked to "thermodynamics", that is to say the influence of temperatures, but also to the movement of ice towards the north, to less polar latitudes, and to a thinner layer of ice on the coast. of the Amundsen Sea.

The summertime " anomalies " have been observed mainly in the western part of Antarctica, which is more vulnerable to climate change than the larger area of East Antarctica.

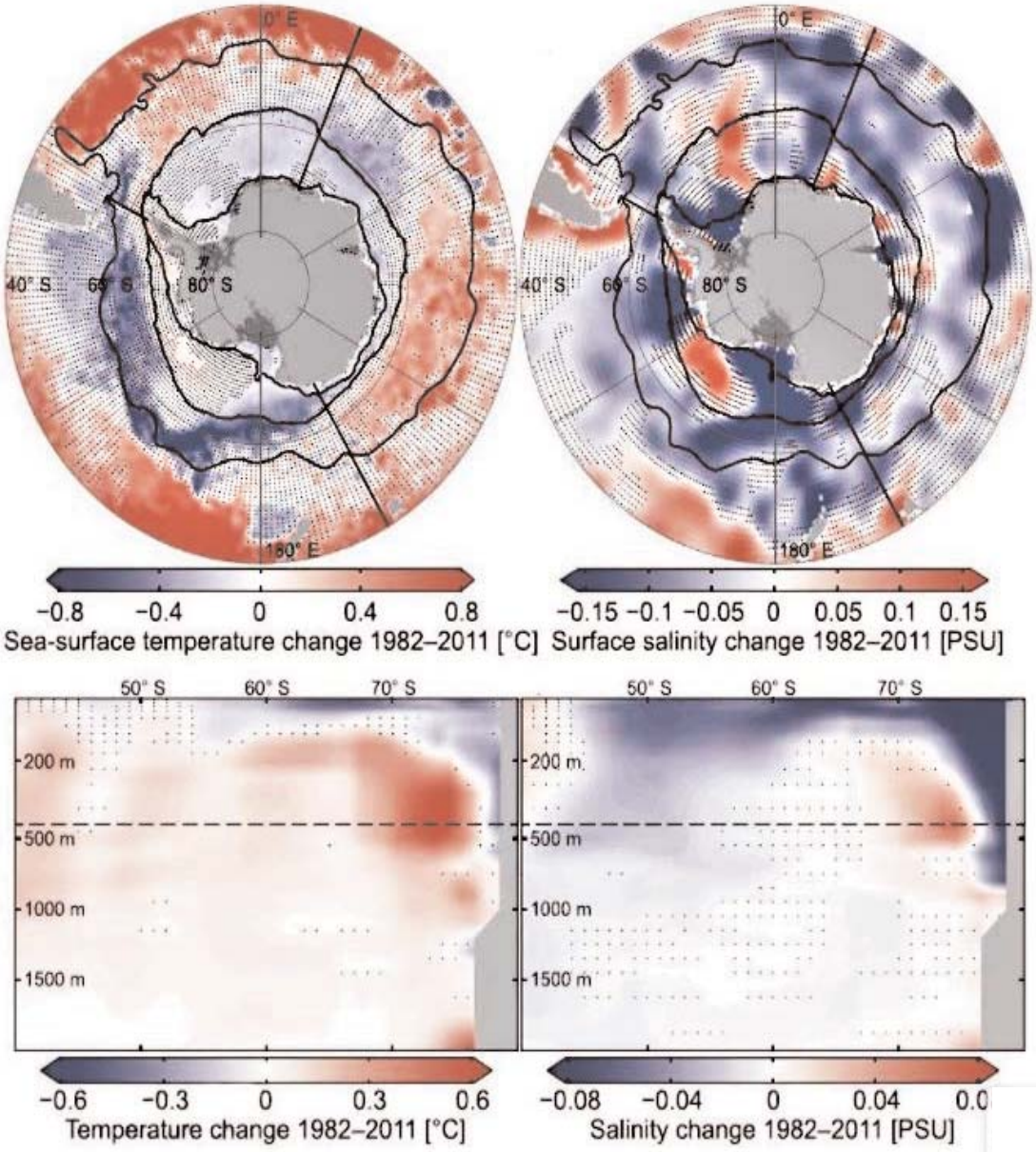
A vicious circle

The melting of sea ice has no impact on sea level, because sea ice is formed by the freezing of salt water.

But less coverage is also cause for concern.

When the white surface of the sea ice, which reflects the energy of the sun, is replaced by the dark surface of the sea, "there is less heat reflection and more absorption", explains Qinghua Yang, one of the co-authors, professor at Sun Yat-sen University. "Which in turn melts more ice, and produces more heat absorption, in a vicious cycle."

The melting of the ice on the Southern Ocean would cause a warming comparable to that due to human emissions, and if we add to this the disappearance of the ice on the Arctic Sea, the warming caused by the darkening of the surface of the Earth in summer has a stronger effect than the effect of human activities. The difference in the extent of the ice would be enough to explain why temperatures do not come down as they usually do in El Nina years.



The behavior of this pack ice is less predictable than that of the Arctic. Warming ocean and air are attacking the ice. Models indicated a decrease but it has not been evident in recent decades. It depends on several factors, the temperature of the surface currents, the melting of glaciers which could bring a layer of fresh water to the surface of the oceans, and the winds. Climatologists were beginning to believe they were wrong, but a first period of significant reduction occurred a few years ago, and now a second is occurring.

In the 20th century, Antarctica was isolated by a strong jet stream, and remained cold. Winds and atmospheric circulation have recently changed around Antarctica, favoring the arrival of warmer currents at the surface of the ocean. Atmospheric and marine currents could perhaps evolve again and promote the reformation of a huge layer of ice. It is also possible that the Antarctic jet stream will be permanently disrupted.

Melting sea ice is currently forming a strong feedback loop of global warming. If this ice disappears, Planetary temperatures could soar. They are influenced by several other factors. The La Nina current at work this year generally caused a drop in temperatures but the melting of the Antarctic sea ice could counteract this effect, and when the Nina ends, the Earth could well reach new temperature records.

The Andes

Our recent studies have shown that the glaciers of the Andes regulate their variability on the surface temperatures of the equatorial Pacific. However, these have increased by 0.8°C since the beginning of the 1970s, following a slowdown in the meridian circulation of the waters which bring the waters towards the equator from the mid-latitudes and then send them back to the mid-latitudes. .

Currently, a significant increase in temperatures is observed in the Andes of Bolivia, Peru and Ecuador . It has been of the order of 0.1°C per decade since the beginning of the 1950s, then it has increased by 0.2°C per decade since the beginning of the 1970s. the water vapor content of the atmosphere, estimated at 0.1-0.2 hPa per decade over the same recent 30-year period. Over this same period and in this part of the Andes, no clear trend, towards an increase or a decrease, is observed in the level of precipitation, but on the other hand we see a strong variability according to the years, we will come back to this.

At the origin of the retreat of the glaciers, should we blame this simultaneous increase in temperature and air humidity? It is tempting to point the finger at the temperature, because we observe that it is well correlated with the mass balance of the glaciers that we measure: put more simply, it is the "warmest" years that record the losses of most significant ice cream and vice versa. But precipitation is also related to temperatures in the Andes, in at least two ways. When it is hot, the rain/snow limit rises on the glacier, which depresses the albedo and automatically increases melting: this is particularly clear on glaciers located close to the equator. In addition, the hot years are also those where the precipitation is the most irregular and deficient, causing the same effect on the albedo (the snow which is not replaced quickly becomes dirty, therefore its absorbing power with respect to radiation increase). The temperature undoubtedly has its role in deglaciation, but it is the albedo that we must put forward the most as the main responsible for the current accelerated melting. The increase in air humidity, too, is important because it changes the nature of the processes on the surface of the glacier: the more humid the atmosphere, the less sublimation is active, which releases energy for cast iron, more effective in terms of ablation, as we have seen.

When we look in detail, we observe that the glaciers react brutally to recurring anomalies in the temperature of the waters of the equatorial Pacific, which reflect an oscillation between two extreme states, the Niño (hot anomaly) and the Niña (cold anomaly) Enso

This oscillation, which is called ENSO (El Niño- Southern Oscillation), affects not only the climate/ocean system of the Pacific basin, but also the climate of the American continent and beyond that of the entire planet.

When the hot anomaly takes place in the Pacific, a few months later the glaciers of Peru and Bolivia react: the melting becomes more important in their lower part, while the accumulation is in deficit in their upper part. In Ecuador, it's the same thing, but it happens a little earlier.

But the mechanisms differ when one moves away from the Equator: in Bolivia and Peru, the precipitation decreases and is more irregular during the summer, which causes the melting to rise sharply, while in Ecuador , the atmosphere warmed by the ocean shifts the rain-snow boundary aloft. The effect is the same, on both sides, it increases the melting on a good part of the glacier and begins its reserves.

If we look in more detail, we see that the glaciers of the tropical Andes follow the temperature curve of the waters of the Pacific and their "slip" since 1976 responds to the increased frequency of El Niño phenomena (1976 is a key date, which mark for oceanographers and climatologists a rupture in the Pacific called the "Pacific shift"). Is this recent warming of the Pacific the reflection of a natural low-frequency variation taking the form of a natural cycle estab-

lished on a multi-decadal time scale. Today (since 1976), more warm oscillations (high frequency of El Niño), tomorrow the pendulum in the other direction, as before 1976, with more frequent cold oscillations (La Niña)? Or is this warming a basic trend, linked to the current accelerated warming of the planet. In this case, the multi-decadal oscillation would be superimposed on a warming trend and the hot phases would become increasingly hot, while the cold phases would become less and less so! It is still too early to decide whether the current frequency of El Niños has anything to do with "global change". For this, it is necessary to question the past to see more clearly, by analyzing archives (oceanic, glacial or other) which would have recorded these events in the Pacific during ancient times...

What is certain, on the other hand, is that if this continues for several more decades as since 1976 in the Andes, a large part (how many representing what volume of ice) of the glaciers are doomed to disappear, and with them vanishes a water resource and also a strong symbol for the Andean populations.

OCEAN IN PERIL

The Gulf Stream is the main current system in the Western Atlantic. Formed east of Florida by several masses of water from the Gulf of Mexico, it is divided into segments, with sinuous lines, directed towards the East and the North-East.

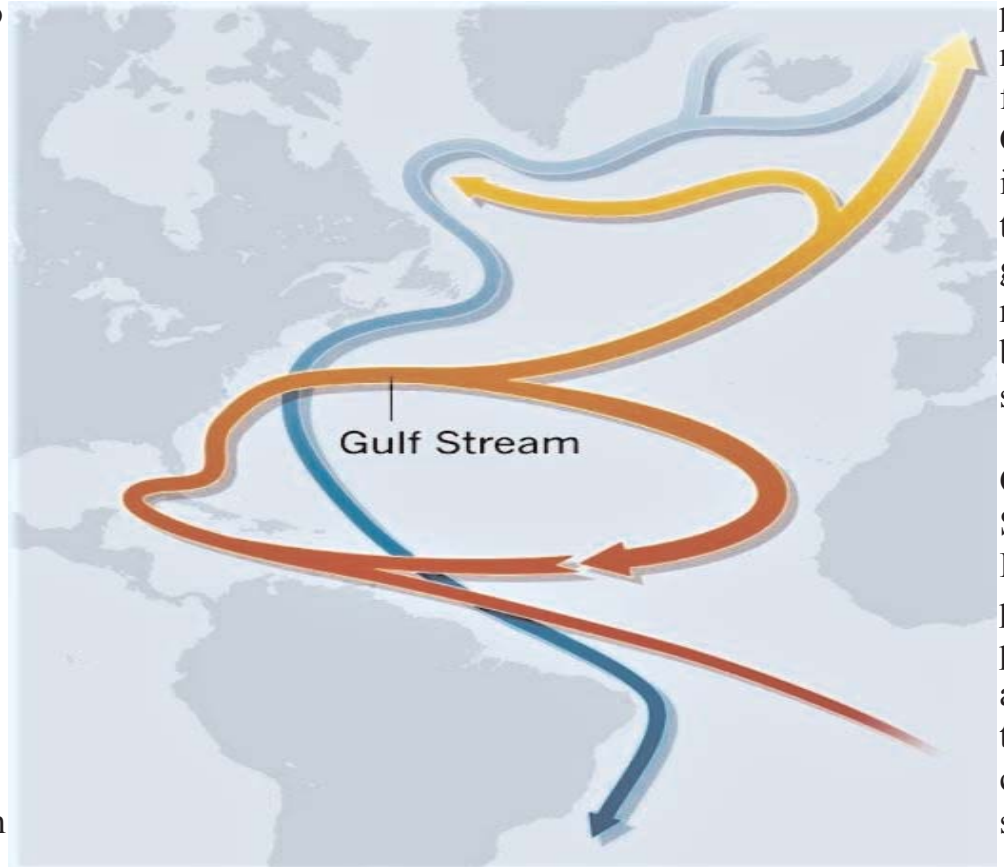
The climate system is a machine for converting and distributing the energy that the earth receives from the sun. It is a complex system with multiple actors. In addition to the sun, the exclusive source of energy for the system, the different terrestrial compartments each play their part. The continents which absorb part of the solar energy and restore it to the atmosphere with an intensity which depends on the properties of their surface and the vegetation they carry. The cryosphere (ice caps of Greenland and Antarctica, ice floes) which sends back, by reflection, towards space a quantity of energy lost for the climate system which depends on the state of the ice but above all on the icy surface . The ocean and the atmosphere which are the two heat transfer fluids from equatorial regions to high latitudes. All these elements of the climate system, including the sun, are constantly evolving with their own speeds which are very different. Any variation, any disturbance of one of them reverberates on the others, which react at their own pace. The climate system is chasing a balance it can never achieve. It constantly varies on all time scales. The main thing for us is that it is sufficiently stable to remain within bearable amplitudes and speeds of variation.

Ensuring the transport and distribution of thermal energy, the atmosphere and the ocean are the dynamic agents of the system. Permanently in contact with each other, they constantly exchange energy with each other and are inseparable. It is the pair that they form that manages the planet's climate on the time scales that concern us. All the difficulty of translating this coupling comes from the fact that they have very different properties and speeds of evolution.

The atmosphere has little memory. It has a very short response time to the disturbances to which it is subjected and it evolves very quickly (photo 1). This is the difficulty of weather forecasting. Currently, the meteorological services advance a seven-day forecast. Despite progress in modeling the atmosphere, there seems to be a limit, a horizon, beyond which it will always be impossible to make a weather forecast, i.e. a time after which the state of the atmosphere will be completely independent of what it was at the initial instant. This horizon is probably about fifteen days.

The ocean has a longer evolution time and, therefore, a much better memory. It plays a dual role: supplying a fraction of its energy to the atmosphere and distributing the other part directly, via currents, on a planetary scale. In a given place, the amount of energy exchanged with the atmosphere depends on the surface temperature of the ocean and therefore on the amount of heat it has transported

so far. The portion of the ocean to be considered in climate processes depends on the time scale chosen. If one cares about weather forecasts within two weeks, the models only need the ocean surface temperature to determine the energy exchanges between the ocean and the atmosphere. During this period, changes in sea surface temperatures are too small to have a significant impact on these exchanges; it would be pointless to complicate the models by involving ocean dynamics. Weather forecast models are strictly atmospheric models. On the climatic scales, on the other hand, this dynamic must be considered: it is the slowest partner, the ocean, which imposes its rhythm on climatic variability. Climate forecasting models, whatever the time scales considered, must necessarily couple the dynamics of the ocean and the atmosphere. Any country can be affected by episodes of drought if it responds to the following climatic conditions: a drop in precipitation for a prolonged period, accompanied by a rise in temperature. Of course, certain regions of the Globe are more vulnerable to these droughts, in particular the tropical and subtropical zones which have a hotter and drier climate. Marine currents are therefore stakeholders in this system. The Gulf Stream plays its part there, neither more nor less, but has acquired a media reputation that masks its dynamic reality.



Gulf Stream at lowest level in 1,600 years

Numerous studies have already looked into the phenomenon. In 2017, an article by Nature Communications advanced a 45% probability of global cooling in Western Europe during the 21st century, resulting in a drop in North Atlantic temperatures of 2 to 3°C. In 2018, two studies published in Nature showed that the Atlantic Meridian Ocean Circulation (AMOC) was at its weakest level for 1,600 years, with a 15% drop in the last 50 years, probably due to the change climate caused by human activities. In addition, the Gulf Stream would be shifting north, resulting in warmer temperatures off the North American coast and colder temperatures south of Greenland.

A matter of salinity

It is the greater evaporation of surface water in the intertropical region, generating a significant surplus of water vapor in the atmosphere and more intense freshwater precipitation at the highest latitudes, which would be responsible for this modification. salinity in the North Atlantic. Waters less loaded with salt sink more difficult to the depths of the sea. This is precisely what is happening with the Gulf Stream north of Iceland. This is where the famous current plunges to the ocean floor to return to the Tropics and then, further still, to the Antarctic Ocean. This deep ocean current is in a way the "return" current of the surface Gulf Stream. the vast global climate machine. This ultimately interferes with, or even blocks the Gulf Stream on the surface.

Consequences: with a Gulf Stream experiencing failures, Europe, deprived of its effects, plunges in turn into a new cold period. Clearly, winters in Lisbon are likely to become as harsh as those in New York. Utopia? The climatic history of our planet shows that such phenomena due

to a considerable influx of fresh water into the waters of the North Atlantic (following the massive unloading of ice from the American ice sheet) have already halted the mechanics of the Gulf Stream. . Result: if the chances of a total disappearance of the Gulf Stream over the next 1,000 years is "negligible", the probability of a temporary interruption is conversely much higher, with a 15% chance of disappearance in the next century. This forecast is all the more likely as the Gulf Stream has already experienced significant variations throughout history. 13,000 years ago, for example, the AMOC weakened, leading to a 6°C drop in temperatures in Greenland. Another slowdown in the Gulf Stream is partly responsible for the Little Ice Age (PAG) that Europe experienced between 1450 and 1850.

Increased drought in the tropics

This phenomenon has been observed since the 20th century. Areas of the world are drying up and we can observe the bodies of water on the continents suffering the effects. For example, the Dead Sea, whose water is receding by about one meter every year, has lost a third of its surface area since 1960 and is now threatened with extinction. And these problems continue and become more serious, like Lake Suesca (Colombia) or Lake Sawa (Iraq) which recently dried up completely, in 2021 and 2022 respectively. We see that continental water bodies are drying up. The tropics are the first affected because they have a hot and dry climate. These bodies of water are disappearing. Current and future droughts are ringing the alarm bells because the consequences are multiple, for fauna and flora but also for humans, for agriculture, water quality and energy production. In Australia, 91% of the Great Barrier Reef has suffered 'bleaching' The world's largest coral reef is threatened by a heat wave, according to a new government report. Around 91% of Australia's Great Barrier Reef suffered "bleaching" due to a prolonged heat wave during the austral summer, according to a new government report released on Tuesday evening. Of the 719 reefs surveyed, 654, or 91%, exhibit some level of coral bleaching. This is the first time that the largest coral reef in the world has been affected by such bleaching during the La Niña climate phenomenon , usually characterized by abnormally low water temperatures.

"Climate change is intensifying and the reef is already feeling the consequences," warns the monitoring report, which points out that this is the fourth wave of "bleaching" to hit the reef since 2016.

Higher death rates

Between September 2021 and March 2022, the Great Barrier Reef Maritime Authority, which published this study, carried out exhaustive surveys on this reef, which is on the UNESCO World Heritage List. She established that the waters began to warm up in late December and that the three main regions where the barrier is located were hit by this phenomenon, which results in discoloration due to the expulsion of algae giving the coral its color. live. Bleached corals remain alive and can recover if conditions improve, but "heavily bleached corals have higher mortality rates," said the report, an early version of which was released in March.

The last sperm whale hunters in the North Atlantic

"A large number of whalers come from the Azores where the ships of Nantucket drop anchor to watch the crews with the strong peasants of these rocky islands… for some reason, but it is among the islanders that the best whalers are recruited . " (Hermann Melville, Moby-Dick, 1851)

Six o'clock in the morning, dawn breaks, I criss-cross the quay. Two men make the same journey in opposite directions, we pass each other. Ritual bomdia are exchanged with a smile. Only dogs seem to be truly active, tirelessly searching for food with their muzzle between their paws.

Seven o'clock, the sun rises on the horizon. There are now more than ten of us pacing and talking calmly. A man with a shaggy white beard on a weathered face scrutinizes me with his deep green eyes. Suddenly, a firecracker explodes. It 's the general euphoria, we pat each other on the back, we shake hands, it's almost a party. There will be a sperm whale hunt this morning. The lookout spotted one a few kilometers off the coast. The sailing whaleboat is launched. It's exuberance, except for me, I'm still waiting.

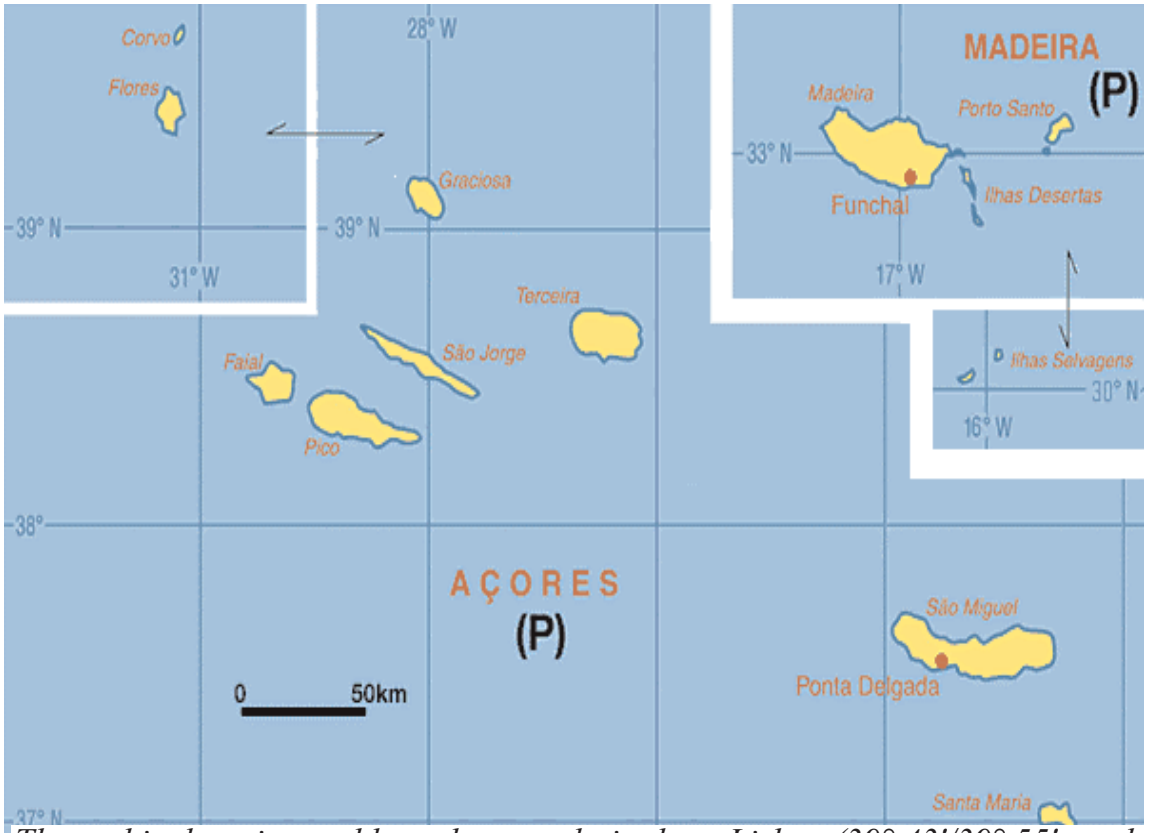
The unshaven, impassive old man looks at me, taking one last puff of his eternal cigarette butt. Here, he is the most respected man, he is called the "mestre ", the master. Over forty years of hunting experience. We expect more than him in the boat. Placing one hand on the hull, he makes the sign of the cross with the other, looks at me again and nods his head in approval; so I too will participate in the hunt.

I board, collapsing with nervousness in the bottom of the motorized whaling boat which will take us nearly half a kilometer from the sperm whale. An almost meditative silence has now settled in, henceforth the gesture will be language. We leave the port of Horta, capital of the island of Faial in the Azores archipelago, a group of islands lost in the North Atlantic, almost the center of the world. These islands of volcanic basalt are a spell of nature so much everything there is impregnated with mysteries; magical stopovers where life has been maintained in the ancestral purity of traditions and where nature has kept all its enchantments. Since 1832, the Azoreans have always hunted the sperm whale using the same method, the one learned from the Basques and which is much more like a race than a hunt. You have to catch up with the sperm whale by weaving between the waves and the breaking waves of the North Atlantic, raise the mast at arm's length, hoist the sail, approach it noiselessly, dart the sperm whale in the

lungs and let yourself be dragged and toss around by the monster, a real aquatic rodeo, until complete exhaustion. And above all to get ahead of the other whalers from the other islands, also in pursuit of the cetacean. Hunting is therefore very different from that carried out by the Japanese, Norwegian and Russian factory whalers who, thanks to cutting-edge technology, almost completely monopolize this industry, which is nevertheless under embargo.

Historically, whaling in the Azores began in 1760. It was introduced by the Americans who learned the technique from the Nattick Indians . In one year, the Azores archipelago became the most important base of call, supply and hunting territory for more than sixty whalers in search of cetaceans. Because of the monopoly of foreigners, sperm whale hunting has never really been profitable for the islanders. Unable to compete against this hunting armada, the Azoreans have therefore developed a more economical type of boat.

In 1894, an inhabitant of the island of Pico, named Marchello built the first typical hunting boat of the



The archipelago is roughly at the same latitude as Lisbon (39° 43'/39° 55' north latitude). It experiences a very humid oceanic climate with fairly small annual variations. The nine islands have a total area of 2,355 km². Their individual surface varies between 747 km² (São Miguel) and 17 km² (Corvo). The volcanic origin of all the islands is demonstrated by the existence of numerous cinder cones and by several caldera stratovolcanoes . Most of the islands are subject to intense seismic activity. Pico, a volcano of a predominantly basaltic nature, with an altitude of 2,351 meters on the island of Pico, is the peak of the Azores and Portugal . In 2004, the population of the Azores was 240,600 and the density of population was 106 inhabitants per square kilometer. Birth rate 12.5‰ and death rate 10.2‰ (2004). The main cities are: Ponta Delgada , on the island of São Miguel (28,000 inhabitants); Angra do Heroismo, on the island of Terceira (21,000 inhabitants); Horta, on the island of Faial (9,500 inhabitants). The nine islands are divided into three groups: The eastern group of São Miguel and Santa Maria. The central group of Terceira, Graciosa , São Jorge, Pico and Faial. The western group of Flores and Corvo.

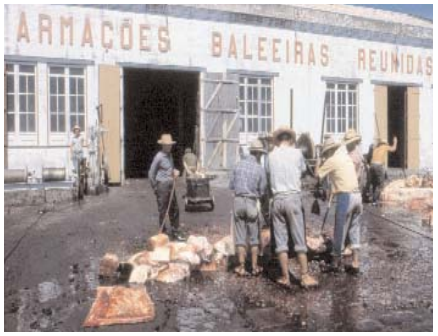
archipelago, a masterpiece that combines aesthetics with utility.

"It is the most perfect aquatic device that has ever taken to sea," writes oceanographer Robert Clarke. From ten to twelve meters long, with auric sail and jib, the Azorean whaleboat can be maneuvered by oar. It is a real tour de force because it is five meters long. Seven men are on board, including the "mestre " at the stern who has the task of driving the boat and controlling the line, while the lead rower also acts as a harpooner. Short and massive like blocks of cement, these hunters are the last living

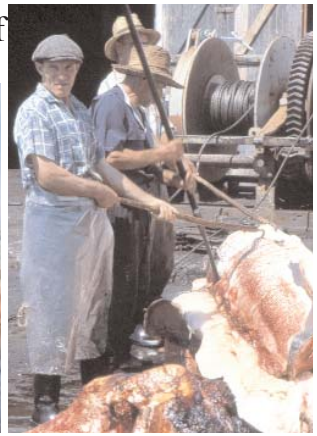
witnesses of a fantastic era that served as the framework for Hermann Melville's famous Moby Dick.
The scenario of a hunt is always the same. When summer comes, lookouts set up in lookout posts along the coast and scan the ocean to spot the arrival of a school of sperm whales. These lookouts have an incredible visual acuity and are mostly experienced ex-hunters. They can, from their lookout post, spot the jet of water from cetaceans nearly thirty kilometers away on a clear day and can even determine the size of the species from the volume of water in this fountain. As soon as a whale is located, the lookout launches firecrackers as if for a holiday to warn the villagers. The hunters rush in their whaleboat towed by a " lancha ", a motor launch, to the hunting area. The only two modern innovations introduced were the motor launch and the radio telephone . Some 300 meters from the animal, the sail is hoisted, the hunt begins between the roller coasters of the Atlantic Ocean.

Standing at the bow of the boat, the feverish harpooner waits for the right

angle to throw his javelin, five to six feet long with a triangular tip. The injured sperm whale dives at such frightening speed that the rope has to be hosed down so that it does not catch fire. An uncertain fight of about ten hours has just started. If there are several victories, there are also as many defeats. Sometimes the more cunning sperm whale dives before the harpoon throw and disappears into the abyssal depths of the ocean. Another time, the rope had to be cut after eight hours of struggle on the captain's orders because the harpoon had not perforated the cetacean's lung. Often we return to the port exhausted and empty-handed under the



gaze of worried women who are waiting to see their husbands or their sons land safe and sound.
Armacoes factory Baleeiras Reunidas Ltd. on Pico Island. Armed with a long, sharp spatula, the seafood butchers carve up large strips of bacon and take them to the oven
to remove the oil. Under the effect of



the heat, the bacon in the cauldrons turns into oil.
The founder then pours the oil into water to cool the oil and purify it: the specific weight of the oil being lower than that of water, it floats on the surface while the impurities sink to the bottom. It is then poured through a sieve and then put into barrels. Other workers work to disarticulate the upper jaw of baleen-bearing whales or collect the ivory teeth of the sperm whale.

Night falls, the cafe comes alive. The day's hunt is dissected from top to bottom and everyone has their own comments. A vapor of "aguardiente " perfumes the air. At eight o'clock, we argue hard, at ten o'clock, we drop like flies under the effect of this liquid insecticide. And that's good, you can't live with the idea of death twenty-four hours a day. So, you have to forget the danger, forget the one hundred and twenty friends who have died in the hunt since the beginning. Forget that tomorrow it will start again… maybe.

(report published in the Montreal newspaper Le Devoir on March 13, 1981)

Cetaceans and humans.

Whaling and the by-products derived from flesh, fat and bones are at the heart of our history. In the beginning, hunting at sea was mainly the Inuit 's own and was based on five species: the whale, the narwhal, the beluga, the walrus and the seal. The Inuit stayed along the coast to hunt seals and whales, which they absolutely needed. The raw meat of seals and walruses was essential to them to feed themselves and to feed their packs of dogs; the skin to make their long kayaks and waterproof boots, thongs and hitches. From the whale, they used, in addition to oil and flesh, the solid bones in which they cut soles for the runners of their dog sled. The imposing skeleton of the whales was used as the framework for the houses and the baleen were used in the manufacture of fishing nets and bows and arrows.

Between the 12th and 14th centuries, the Basques practiced whaling along the coast between Bayonne and Bilbao. Biarritz will be the most important port for Basque whalers for three centuries. Encouraged by their successes and the increase in supply and demand, the Basques began to pursue whales on the high seas. They thus sailed north up the coasts of Europe to reach Iceland in 1412 (Ruspoli). In contact with the Viking islanders and their sagas, they surely learned of the existence of a mythical land, Vinland where the whales went to take refuge. From Iceland to America there is only one easy step for these seasoned sailors. According to historically recognized data, the Vikings (Norse) departed from Scandinavia in the 9th century to Iceland and Greenland and subsequently continued their explorations westward to reach the coast of Labrador and the Island of Land- New. For now and until proven otherwise, Helluland would be Baffin Island and Markland would be Labrador. Baffin Island provided the most prized bird for falconry, ie the white falcon while Labrador provided the timber they needed. Vinland is said to be located at Anse-aux-Meadows (Newfoundland) where Leif Eriksson, son of the famous Eric the Red, is said to have founded, around the year 1000, a small trading colony called Leifsbudir , in the heart of a region known to be prolific in whales and cod.

Some historians think that the Basques, after the Vikings would also have "discovered " America before Christopher Columbus and would have kept this discovery secret, wanting to protect their monopoly of cod fishing and whaling. The Basque sailors were neither explorers in the service of the State, nor colonizers but fishermen engaged in a commercial activity, hence the importance of keeping the secret on the prosperous maritime routes. (Jean-Pierre Proulx,1986)

Around 1526, several dozen ships left the Basque Country to hunt whales in the Gulf and the estuary of the St. Lawrence during their migration between June and August. On the coast of Labrador and Newfoundland, towards the Strait of Belle-Isle, archaeologists have unearthed remains demonstrating the presence of Basque ovens for the treatment of " ballaine " oil. Continuing their exploration of the north coast of the St. Lawrence, the Basques came to hunt whales in the waters of the Mingan Archipelago as early as 1550. At the end of the 19th century, the Comte de Puyjalon noted in his diary the structures of masonry, while archaeological digs undertaken by René Lévesque in the 1970s confirmed the use of an oven on Île Nue and Île du Havre de Mingan by the Basques. Île aux Basques on the south shore of the great river became between 1580 and 1860 the most important processing center for whale and seal oil. Île aux Basques on

the south shore formed, with Les Escoumains and Tadoussac at the mouth of the Saguenay on the north shore, the most prolific whaling maritime triangle within the Canadian coasts.

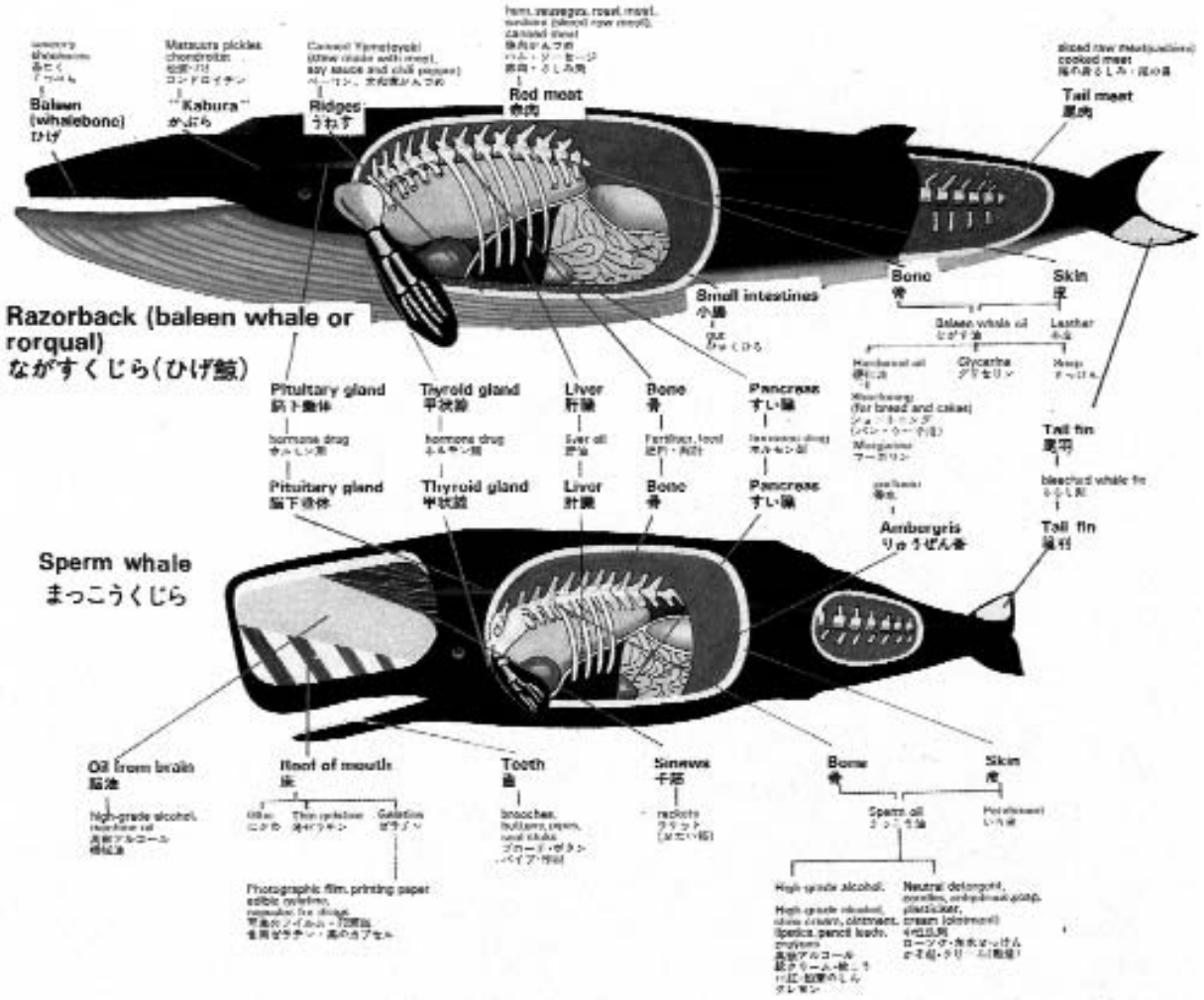
While the Normans, Bretons and Rochelois had vessels of 50 to 100 tons, the Basques used caravels of 200 to 400 tons manned by crews of 40 to 70 men. On board, between three and six fishing boats (cod) or whaling boats twenty or thirty feet long, with flat bottoms and flared sides, were used for the work of the crew. The ancestral technique they developed lasted until 1980. Once, the cetacean spotted, the whaler, 8m.30c long by 1m.80c wide and its crew: five rowers, a helmsman and a harpooner, sails towards the prey. 200 meters from the animal, the sail is lowered and the rowers take over until the harpooner can do so. After the first blow which pierces the lung, a second harpoon is launched with a buoy which slows down the dive and tires the animal. At each ascent, the whale is struck again with darts and javelins until death ensues. Brought back to land, the whale is cut up and the bacon placed in an oven where the melted fat is collected then it is run through a fine sieve and the oil is put in barrels. (Belanger, 1971)

In addition to building furnaces for the preparation of oil, they erected scaffolds there for the drying of cod by exposure to the sun. The Basques were among the first to trade manufactured goods in return for furs, which were increasingly demanded by French hatters. To do this, they transport hundreds of metal objects from Europe: knives, axes, pots, but also glass beads and clothing. At first the Basques treated cordially with the Eskimos. But in 1610, the kidnapping of the wife of an Eskimo chief, as for the Trojan War, set fire to the powder. Throughout the century, the Basques had to protect themselves and arm the ships against the incursion of the Eskimos. On the other hand, relations remained friendly with the Amerindians, although Father Lejeune reported that a young Basque was eaten by them during a famine. Then around 1636, the war between Spain and France led to the requisition of Basque ships and crews. The Dutch take advantage of this to hire Basques to learn the art of whaling. In just a few years the mighty Noordsche Companie d'Hollande holds the hunting monopoly in Greenland and Spitsbergen. Amsterdam becomes the most important European market for whale oil and baleen.

In 1685, the Basque Country had only 721 experienced sailors, the workforce of only 18 ships. Then around 1700, the majority of Basques and other whalers left the Gulf of St. Lawrence and followed the herds of whales now concentrated in Greenland. (Frenette , 1996; Belanger, 1971). Subsequently, the whalers followed the routes traced by the whales in their migratory journey, which made Yvan T Sanderson say: by following the whale, Westerners discovered and conquered the planet.

Around 1688, envoys from the King of England who came to America to study the economic conditions of the American colonies recommended, following the decline in the populations of beavers and other animals with excessively exploited furs, that whaling should be made the economic engine of the East Coast States. Whale oil was indeed the only source of energy available for the lighting of American homes and cities then in full expansion. In 1748, whaling and the oil trade became a powerful factor in American economic growth and the heart of this flourishing business was located in Nantucket, the island off Cape Cod which inspired Herman Melville's famous Moby Dick. (Williams, 1988) American hunters loved to confront the tyrant of the seas, the sperm whale described by the religious sect of the Quakers as the diabolical Leviathan of the Bible. However, this great devil possessed, for his greatest misfortune, unprecedented riches such as ivory teeth, ambergris highly sought after by perfumers and spermaceti or whale white, also coveted by candle makers. (Cazeils , 2000) Indeed, whale white gives a beautiful flame, the clearest and most luminous of all and its fame went around the globe in record time while the cosmetics industry discovered the musky aroma of ambergris of sperm whales and above all its enormous power to fix natural essences.

The whale became highly sought after as manufacturers developed new commercial products. The war between Holland and England around 1780 dealt a fatal blow to the whaling industry of the two countries and allowed the Americans to take control in turn. The big oil traders benefited greatly from the innovations brought to market by the traders. Around 1850, the whaling fleet employed over 70,000 men. The great period of whaling, during which 80% of the animals were taken by American whalers, ended around 1900. (McHugh , 1974)



Whale blubber served as a condiment and was used for frying. Liver and tongue were the most popular and were eaten roasted. The flesh was used as animal food. The oil made a good lubricant for watch mechanisms and other motors, in addition to making excellent soap and other products including lipsticks and other cosmetics, nitroglycerin, paint pigments, printing inks, insecticides, varnishes, wax, antifreeze, transmission oil, gelatin. Bones, leather and especially baleen are also used to make a host of various objects; the whale penis, 5 to 6 feet, was transformed into a golf bag. So much so that we can once speak of an era of the whale identical to that of oil today, where empires were formed on its back. Let us think of candle companies, manufacturers of musk, medicines, umbrellas, brushes, corsets, buttons and more artistically, sperm whale ivory sculptors and horn cutters.

In this regard, however, Japan is an exception. While in the West, despite several promotional campaigns, whale meat is consumed very little in Europe and America, except in the event of a shortage of beef, as in England in 1947. Only the Norwegian company Kosmos succeeds in creating a market for whale meat in the form of animal feed. The blue whale was exterminated to feed dogs and cats. The situation is different in Japan, where culinary habits centered on seafood give whale meat a unique and greatly appreciated dietary status that replaces the consumption of beef.

All parts of the whale are used and eaten, the Japanese do not waste anything. Onomi , delicious meat from the base of the tail is mainly used in sashimi which is minced and eaten raw. The akaniku , red meat from the back and belly is used in grills or transformed into ham and sausages mixed with the munaniku (breast) and the aburasunoko (fins) One and the sunoko , meat and fat from the furrows between the jaw and belly form whale bacon. The fatty acids

in the oil form the margarine. Finally, kohige (gum), fukiwata (lung), kyakuhiro (small intestine), mamawata (kidney), takeri (penis), and kaburabone (nose cartilage) are cuts and delicacies . (Itabashi , 1986)

Ironically, it was the discovery of oil in 1851 that saved the whale from complete extinction. Gradually replacing whale oil as fuel, petroleum, mainly kerosene, ushered in a new era. Whale oil prices fell while operating costs rose. One by one, the whalers were assigned to other trades or simply discarded. The revival of hunting in the 20th century corresponds to the invention of the harpoon gun and the explosive head by the Norwegian Swend Foyn and especially to the appearance in 1925 of factory ships with an inclined ramp at the rear which allowed the expansion of the great maritime odysseys in all the Arctic and Antarctic seas. Such a factory ship could handle more than 2000 whales in a single fishing campaign. From that day on Norway became a major player and within a few years established hunting stations all over the world. As early as 1913, Dr. Charcot sounded the alarm and publicly denounced the shameless carnage of cetaceans and demanded that an international agreement be quickly signed to ensure the protection of young calves and establish protection zones. (Cazeils , 2000)

The experience of the First World War showed that the supply of fatty substances was Germany's Achilles' heel. Hitler understood the lesson and in 1933 announced his intention to build a whaling fleet. All bakeries and restaurants were forced in 1935 to use margarine containing whale oil. This decree clearly showed that Nazi Germany was setting up a war economy.

During the Second World War, the need for whale oil increased enormously, not only to compensate for the shortage of vegetable fats but above all because whale oil is essential for the manufacture of explosive nitroglycerin in the oil industry. armament. In 1938, a record year, 55,000 cetaceans were killed. Faced with the announced slaughter, an International Whaling Commission was created in 1946, it was in fact a whaling club which aimed to rebuild the whaling industry seriously affected by the Second World War. For years, this Commission ignored the advice of its own scientific advisers on the risks of whale extinction while countries like Iceland, Norway, the Soviet Union and Japan ignored the innocuous sanctions decreed by an organization without power. It will be necessary to wait until 1986 under the pressure of the governments more and more concerned because their better informed population so that a moratorium prohibits the commercial hunting of large cetaceans.

From the outset the Commission was influenced by economic considerations rather than by the conservation requirements of the species demanded by ecologists. Nineteen countries adhere to it, establish quotas but are unable to enforce them. Today, some countries like Norway and Japan are trying to circumvent the moratorium against commercial whaling under the pretext of scientific studies and research when in reality it is disguised commercial whaling. The fight for the survival of cetaceans is far from over. On October 17, 2006, Iceland announced its intention to resume commercial whaling and a few days later, the first whale was killed and skinned. Everything has to be started over.

Whales are for us the symbol of the wild world. Yet cetaceans, dolphins, killer whales, porpoises, belugas, sperm whales and whales are "civilized " beings who know song, music and communicate with each other with a developed, if not sophisticated, language.

And yet, we more willingly consider the existence of intelligent beings on other planets and galaxies than on our own planet. How many science fiction writers have crafted stories of parallel worlds and galactic civilizations without ever suspecting that such a scenario was unfolding on earth right now?

" Perhaps we should now establish a new category of animals, completely separate from man, but granted intelligence, social organization and a consciousness comparable to that of man. If we had enough humility to accept this possibility, perhaps we would

discover that we are at the dawn of a new era of understanding life . (Horace Dobbs , 1977)

Cetaceans are present in all the legends of the different human civilizations. For the Inuit, the male symbolizes sexual virility and the female, the nurturing and protective mother.

Among the ancient Greeks, legend has it that cetaceans were messengers in direct contact with the gods and personified virtue, love of men and the joy of living.

Pliny the Elder, a Roman scholar, inscribes this relationship between humans and dolphins under the sign of friendship and loyalty.

The Polynesian peoples also venerate the dolphins because it was they who guided them across the vastness of the Pacific Ocean to the fertile islands and who saved the Maori navigators from drowning

during a cyclone by carrying them on their backs to at the shore of New Zealand. As much among the Indians of Canada as among the Incas of Peru, the strength and courage of the orca or killer whale are highlighted in several mythologies.

A Nootka legend, Indians of British Columbia, has it that a white wolf, endowed with supernatural powers, transformed into an orc. Since that day, killer whales are spotted white and move in packs like wolves. In the Islamic tradition, the whale is the being that supports the earth floating on the waters and on which rests the creation of the world. When she moves, her movements cause the earthquakes. (Whales and Dolphins, Elsa Editions, 1998)

The largest fish in the world die silently from collisions

The nature of the greatest travelers of the seas is no longer, for a few decades, what we believe. Cargo ships and tankers rival the largest inhabitants of the oceans in size, including whale sharks whose numbers are mysteriously dwindling despite international protection measures.

Rhincodon whale sharks typus are the largest species of living "fish" (chondrichthyans) as some specimens can measure up to 20 meters in length. They are emblematic of the beauty of marine organisms but also of their fragility in the face of anthropogenic activities. The IUCN Red List classifies R. typus as a species in danger of extinction and the number of these planktivorous giants continues to decrease despite strict regulation of the trade in its flesh and fins since 2003. The hypothesis collisions of individuals with large ships has just been evaluated on a large scale and the results are published in PNAS.

The same places of frequentation
The study authors were able to track the movements of several whale sharks, which they compared with the areas frequented by large ships. They indicate that 92% of the horizontal area used by R. typus is also frequented by these vessels (>300 tonnes) and that almost 50% of the depth used by these sharks is also common to that of these vessels.

Areas frequented by whale sharks and large vessels are where sharks most often die from collisions and these include coastal gulfs. The authors also indicate that the last known position of many whale sharks is in an area with a high risk of collision.

The last position records of these individuals appear to indicate that the bodies sank to the ocean floor after the individual was involved in a collision. This would explain the fact that the numbers of R. typus continue to decrease despite protective measures and without the bodies of the victims being found. The authors therefore call for the implementation of protective measures against these collisions, in a world where maritime traffic continues to increase.

Fishing and Big Killer Boats for whales in the North Atlantic
Between 1979 and 2009, efforts to save North Atlantic whales were largely ineffective. Researchers have studied the observed deaths of large cetaceans over this period. When a cause is found, two times out of three, it is human activity, fishing or maritime traffic. There are, however, some glimmers of hope.

The North Atlantic is home to several populations of cetaceans in danger of extinction. The case of the right whale Eubalaena glacialis , or Biscayan whale, is of particular concern. Only about 460 individuals, some of which can measure up to 16 m in length, would still evolve off the Canadian and American coasts. Several human activities, such as fishing and maritime traffic, would partially explain this small number.

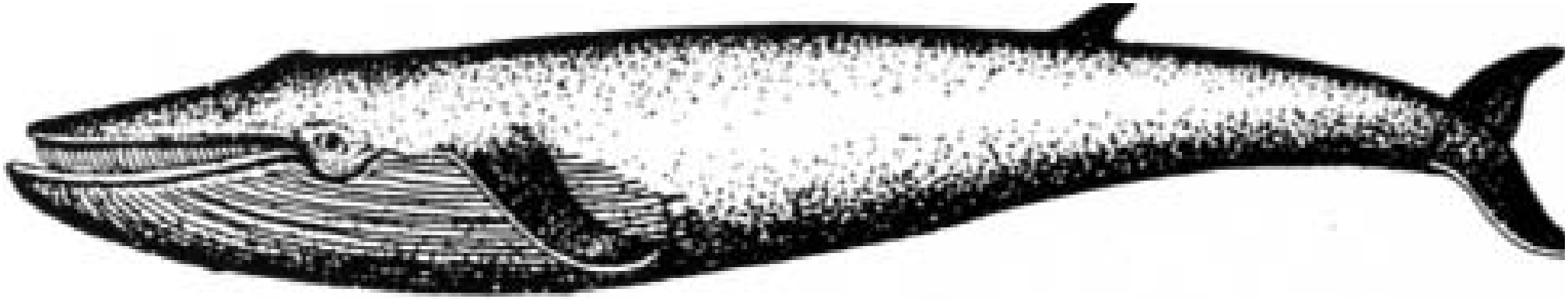
Biscay whales, like other species, are said to regularly lose their lives after becoming entangled in fishing gear. No longer able to rise to the surface, they die by drowning. Ships are responsible for many collisions causing death or serious injury to cetaceans. Measures have been taken to reduce its importance. The United States has thus prohibited all navigation, or limited the speed of boats over 20 m to 18 km/h, in certain waters frequented by these marine mammals. But is it effective?

All deaths of 8 cetacean species in the northwest Atlantic between 1970 and 2009 were listed by Julie van der Hoop of the Woods Hole Oceanographic Institution (WHOI). Overall, and according to figures published in the journal Conservation Biology , the protective measures put in place during this period were ineffective!

Currently, the northeast of the Atlantic Ocean is traveled daily by nearly 80,000 fishing vessels. The phenomenon of overfishing is accentuated, the number of boats increases and the whales have to make their way more and more between these gears. But it is not only fishing activity that is increasing. In some regions of the globe, the observation of whales in their natural environment, the whale watching , is developing at high speed. The commercial form of this practice has intensified over the past 20 years, with scores of lucrative structures emerging, particularly in areas where females give birth and brood their young.

tinued to grow between 1990 and 2009.

Protective measures were put in place in 2003 in many places but no convincing effect was observed in 2009 on a large scale! Local efforts paid off, however. Relocating the shipping route taken by ships in the Bay of Fundy, between the provinces of New Brunswick and Nova Scotia in Canada, would thus have made it possible to reduce the number of deaths caused by collisions among right whales.



Nets and propellers are fearsome In all, 1,762 deaths have been reviewed, including 122 of North Atlantic right whales, 473 of humpback whales (Megaptera novaeangliae) and 257 fin whales (Balaenoptera physalus). The causes of death could be determined for 742 individuals (approximately 42% of cases), and for these, human activities alone explain 67% of deaths! Nearly 323 whales would have lost their lives by becoming entangled in fishing gear, 248 would have died of natural causes and finally, maritime traffic would have caused 171 fatal collisions. A temporal trend has also stood out: the role played by humans on cetacean mortality has con-

New advances will be made possible by the spatial data provided by Julie van der Hoop . Thanks to the precise knowledge of the places prone to accidents, new protection zones will be set up with increased precision. The greatest number of collisions has, for example, been recorded near Cape Hatteras in North Carolina (United States), a place where no particular conservation measures have been applied. Any gesture made in this region can only be beneficial.

In danger ! Hawaiian humpback whales.

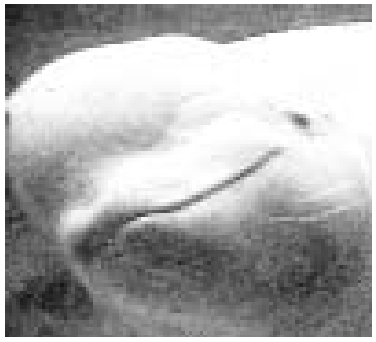
Whales strangle themselves in abandoned fishing lines in the open ocean or starve to death, their stomachs clogged with plastic. In March 2013, for example, a sperm whale, stranded on the Spanish coast, had 17 kg of plastic in its stomach. It was so clogged it punctured. In addition, some cetaceans, Cuvier's whales in particular, wash up on the beaches, completely bewildered by the sounds of sonar, while others are illegally hunted by certain countries. The increase in human activities on the oceans poses a serious threat to cetaceans, and in some regions collisions between ships and whales are the primary source of threat.

In particular, southern right whales can be observed in the Valdés Peninsula in Argentina, or humpback whales in summer in the lagoon of New Caledonia, or in winter near the Hawaiian coast. The calving season has just started on the side of the Hawaiian archipelago, and in this context, the NOAA draws attention to the few precautionary measures to be observed in the astonishing sanctuary that these waters represent. The problem of collisions between small or medium boats and cetaceans is growing, it is becoming the main threat to the species. According to a report, published in the Journal of Cetacean Research and Management, NOAA scientists are analyzing historical records of collisions between whales and ships during the period 1975-2011.

Calves are endangered
In the past 36 years, 68 collisions have been reported. All involved boats under 22 m, i.e. sizes corresponding to whale boats. watching . In 63% of cases, calves or young adults were struck. The latter come to the surface more often to breathe, which probably exposes them to more collisions. However, scientists are unable to determine the number of whales killed. It is difficult to assess the impact on the mortality rate since these collisions occur off the coast, and cetaceans do not always die instantly.

In this whale sanctuary, as in many others, boats are not allowed to approach marine mammals closer than 100 m, and planes 300 m high. But very often, by the lure of profit, whale agencies whatching do not hesitate to transgress these rules. And if they respect them, it is the browsing speed that is regularly called into question. Indeed, these boats move at 10-15 knots, too fast to avoid a collision if a whale appears unexpectedly.

The observation of whales in their natural environment has become a veritable industry. In 2009, IFAW reported that the activity had generated 1.7 billion euros in profits for the year. In less than 20 years, a dozen developing countries, such as Nicaragua, Laos or Cambodia, have gradually developed this new form of tourist activity. Many emerging countries, benefiting from the presence of cetaceans in their territorial waters, could well get started in the coming years. Faced with such an expanding market, it is therefore urgent to make these activities responsible.



Fauna and Flora

Increasingly localized threats

The various ecosystems of the planet are unevenly altered, but many have been modified by man. Some regions are already weakened with species that have become rare, such as around the Mediterranean or in Africa.

Thousands of species doomed to extinction

Not all species groups are equally threatened. Very diverse, birds are proportionally much less affected than amphibians and mammals.

IENDANGERED INSECTS

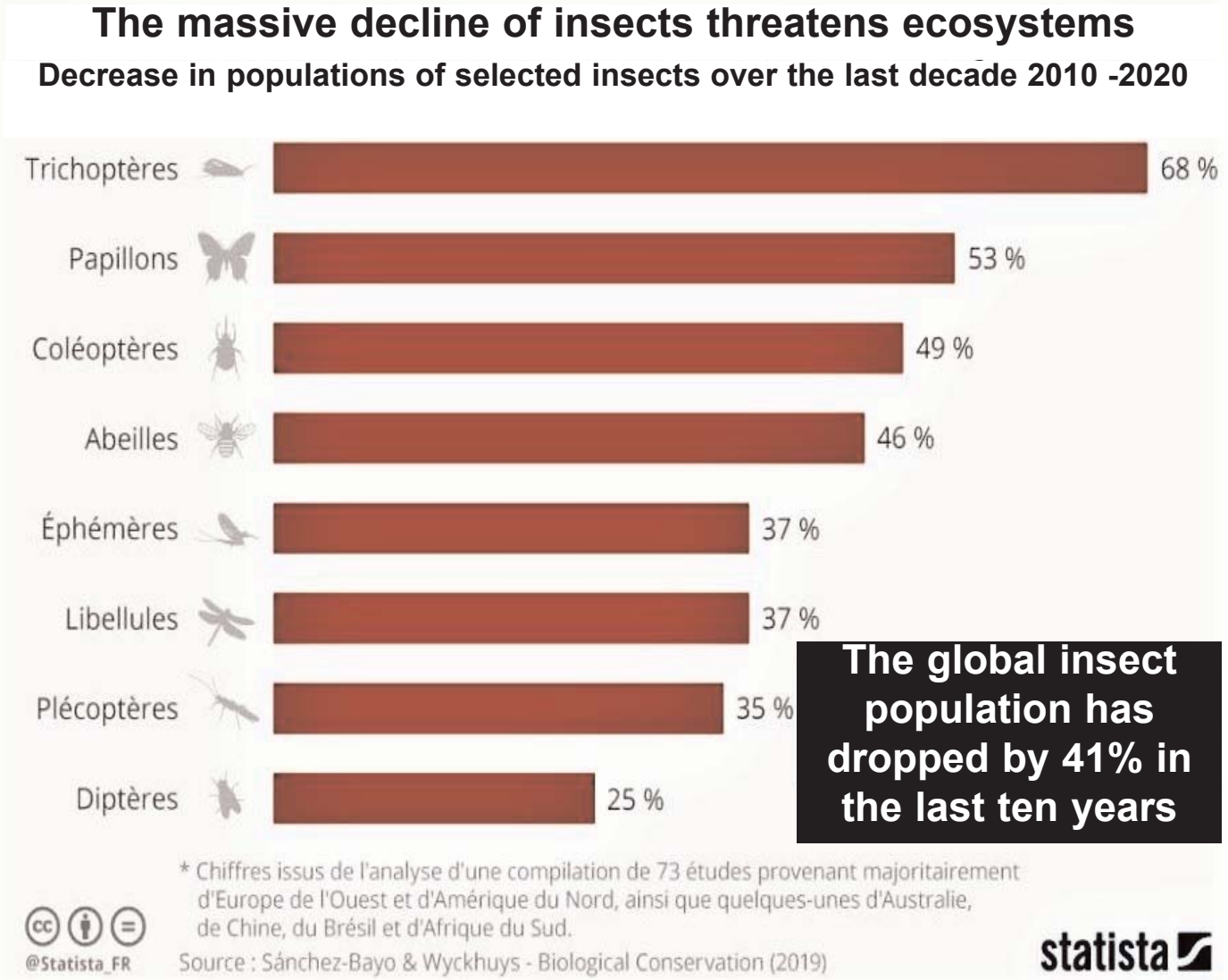
Since the origin of life, plant and animal species evolve, adapt or disappear. It was in 1858 that Charles Darwin exposed the theory of evolution by natural selection, which long before the discovery of genetic mutations (Mendel, beginning of the 20th century) put forward random variations offering certain species the power to adapt, dominate and survive the weakest. This description of natural evolution did not take into account that less than a century later, man would develop activities responsible for profound upheavals in natural cycles and inflict irreversible damage on our planet.

More than 40% of insect species are in decline worldwide and a third of them are endangered. Butterflies, flies, dragonflies, bees... Which are the most threatened?

When we speak of evolution in paleontology, apart from the great crises which are at the origin of massive extinctions, we are talking about climatic changes which have developed over several million years and which cannot be perceived scale of a human life.

Insects could disappear from the surface of the Earth within 100 years, according to a large meta-study published in February 2019. Over the past 30 years, insect populations have decreased by 2.5% per year. , on average, and their rate of extinction (species not observed for more than 50 years) is eight times higher than in mammals, birds or reptiles.

The decline is particularly marked in Trichoptera (a genus that resembles moths) which have seen their population decline by 68% in the last decade. Because of their aquatic larval stage, they are particularly vulnerable to anthropogenic disturbances in watercourses. Butterflies (Lepidoptera) are also disappearing at a worrying rate (53%), as shown in the Statista graph below.


The massive decline of insects threatens ecosystems
Decrease in populations of selected insects over the last decade 2010 -2020
Trichoptères
68 %
Papillons
53 %
Coléoptères
49 %
Abeilles
46 %
Éphémères
37 %
Libellules
37 %
Plécoptères
35 %
Diptères
25 %
The global insect population has dropped by 41% in the last ten years
* Chiffres issus de l'analyse d'une compilation de 73 études provenant majoritairement d'Europe de l'Ouest et d'Amérique du Nord, ainsi que quelques-unes d'Australie, de Chine, du Brésil et d'Afrique du Sud.
@Statista_FR
Source : Sánchez-Bayo & Wyckhuys - Biological Conservation (2019)
statista

Disappearance of insects: a domino effect

The main causes of this massive disappearance are the loss of habitat due to intensive agriculture and urbanization, pollution (mainly fertilizers and pesticides), diseases and climate change. The phenomenon is not only worrying in terms of biodiversity, but above all because insects are essential for the pollination of plants; they are at the base of the food chain.

Their rarefaction thus constitutes a direct danger for birds, amphibians or reptiles. The only good news: the number of generalist species with better adaptive capacities is on the rise, with these occupying the niches left vacant by the others.

Climate change and intensive agriculture have halved the number of insects in the world over the past 30 years, according to a new British study. This carnage could explain mysterious variations in agricultural productivity.
Climate or agriculture?

Both are harmful to insects. "Climate change is affecting insect populations, but intensive farming is a very big aggravating factor," says Charlie Outhwaite, of University College London, who is the lead author of the study published last week in the Nature magazine. In regions where 75% of natural habitats are preserved, insect populations have declined by only 7%. But in regions where only 25% of natural habitats are preserved, the drop is 63%.

Fewer insects or fewer species?
Fewer insects, but also 27% fewer species. "Some species have unique functions in an ecosystem, so that's particularly concerning," says Outhwaite. In regions where only 25% of natural habitats are preserved, the decline in the amount of species was just over 60%, while in places where more than 75% of natural habitats are preserved, the number of cash decreased by 5%.

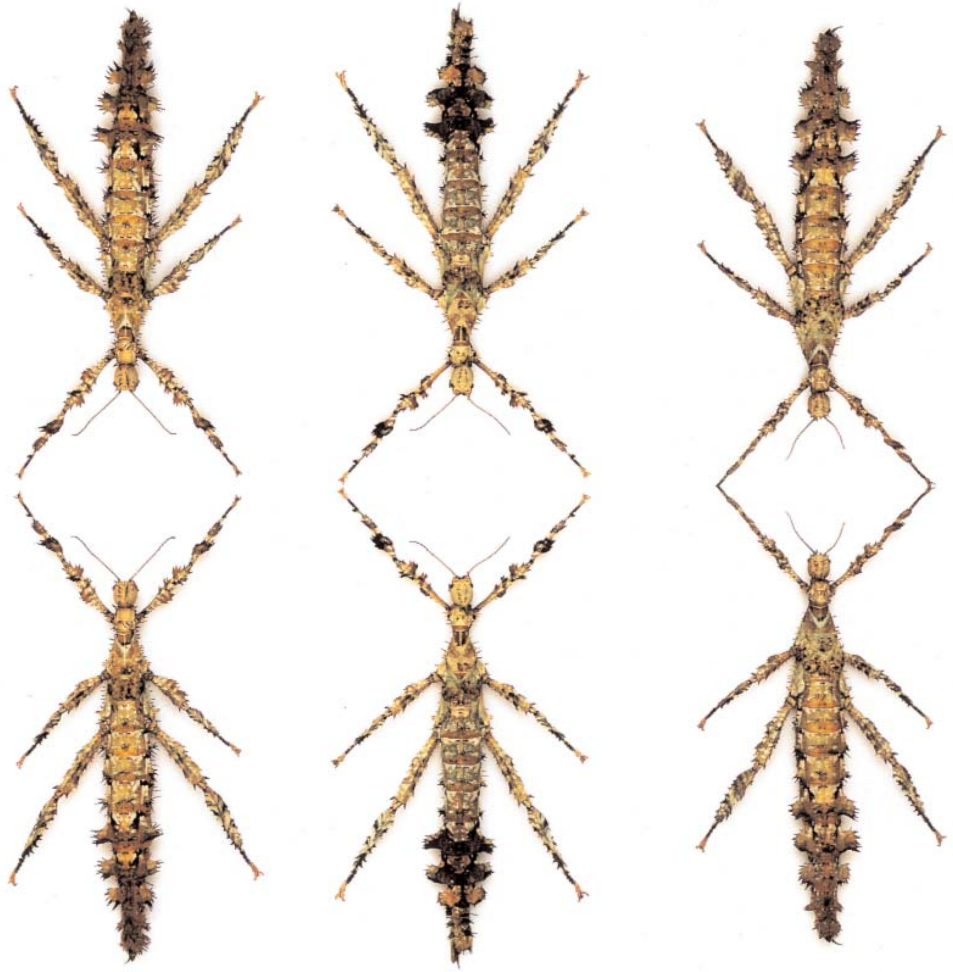
What exactly we measured
This is an analysis of 18,000 insect species, drawn from data collected at 6,000 locations around the world between 1992 and 2012. In all, there are over 700,000 measurements of insect abundance. These databases had been generated by 264 other studies, and the London biologists harmonized them. In particular, they took 'sampling effort' into account to prevent studies with less sampling from giving an artificially low reflection of the amount of insects. Climate change has been measured since the beginning of the 20th century.

Why don't we see the effect of this carnage?
"These may be effects that we are not measuring at the moment, says Ms. Outhwaite. There are variations in agricultural productivity that we cannot fully explain, it may be a factor This is the first time that we have had an overall portrait, not just of a few species, and it is also the first time that we have measured the combined effect of climate and intensive agriculture. lack of studies on the role of insects in ecosystems."

The effects are greater in the tropics, although the temperature increase is greater in northern latitudes. "This is particularly worrying, because the tropics are very rich in biodiversity and there are fewer studies there than in northern countries," says the British biologist. According to the study data, the decline in the number of insect species exceeds 60% in the tropics when agriculture is intensive, while it is minimal elsewhere. In some cases, global warming could even benefit insects at high latitudes.

According to the study data, the decline in the number of insect species exceeds 60% in the tropics when agriculture is intensive, while it is minimal elsewhere. In some cases, global warming could even benefit insects at high latitudes.

Measure temporal fluctuations in insect numbers. Some studies have shown that insect populations decline and increase over time, which may reflect adaptation to climate change.



The story of the bee
The honey bee is a very sophisticated insect that has been constantly evolving since its appearance millions of years ago. The very first bee was discovered in Burma. Fossilized in amber, it would be 100 million years old! It is very likely that the bee originated in the Far East. Originally, it looked more like a wasp and fed on other insects rather than nectar and pollen. We don't really know when she decided to become a vegetarian, but when you think about it, between eating a fly or enjoying the delicious sweet nectar of a cherry blossom tree, the choice is quickly made.

Today, bees are found all over the world and there are approximately 20,000 different species. These range from bees, giant "leaf cutter" bees that can be over 3cm long to the dwarf bee, which measures barely 2mm. The honey bee is only one of these species and most other bees are solitary and do not live in colonies. Bumblebees, for example, live in underground burrows.

Scientists believe that in addition to pollinating our crops, bees are also responsible for the immense variety of flowers that we can observe today in the world. Most flowering plants are unable to self-pollinate and once relied entirely on the wind to transport their seeds. However, finding that the wind was not very effective, the plants dressed in bright colors and patterns to attract bees to carry their seeds. As a reward, the plants began to offer them very nutritious nectar. The bees drink the nectar and take it to their hive in a specially designed stomach. They then share it with the queen, of course, but also with the brood and the bees remaining in the hive.

For prehistoric man, the discovery of honey was as overwhelming as that of fire. The first honey collectors, who did not yet know the combination and the protective veil, suffered as much as if they had to grab a stick straight out of the fire. However, the courage was quickly rewarded because it seems that at the time already, the man had a penchant for sweets.

During antiquity, honey was the most used ingredient to sweeten food and alcoholic beverages. Honey harvesting was such a central activity that some parents began naming their children after bees. Indeed, the first names Déborah (Hebrew) and Mélissa (Greek) both mean "bee". Honey has also been used as an antiseptic solution for at least 100,000 years. In ancient Egypt and the Middle East, it was used to embalm the dead.

In fact, people did not start keeping bees at home until the time of ancient Egypt. Egyptian paintings depicting beehives suggest that bees have been domesticated for at least 5,500 years.

The Egyptian hive was then very rudimentary: most of the time it consisted of a simple upturned straw basket. This technique is still used today, especially to accommodate a colony of bees that has just swarmed.

These very first hives were not designed to last over time. Indeed, honey could not be harvested there without destroying it, and therefore annihilating the colony. The system only worked if the colony produced enough bees to form a swarm, which then had to be caught and held until the following year for it to produce honey again. Otherwise, a new swarm of bees had to be created each year. Over the years, beekeepers realized that they had to find a more elaborate technique, which would allow them to keep the same colony of bees year after year to produce more honey and develop the apiary.

Lorenzo Langstroth is the man who made the discovery that would revolutionize beekeeping. He realized that the bees moved everywhere inside the hive, provided that they were left with an opening of 6 to 8mm in diameter. If the holes are bigger or smaller, the bees plug them. Langstroth called his discovery "spazo di ape" ("space for bees") and it proved to be crucial insofar as it allowed the development of hives with movable honeycomb frames. Thanks to this, the beekeeper was able to remove the frames and the honey without destroying the hive but also to start manipulating his colony to help it develop. This discovery is often considered the starting point of modern beekeeping.

Sacred bees, endangered bees

The melipone bee, whose honey was prized by the Mayans, is experiencing a renaissance after being on the verge of extinction thanks to beekeepers in Yucatan, Mexico. Mexico is a major producer and exporter of honey; the industry is concentrated mainly in the Yucatan peninsula.

For several years, beekeepers have complained about threats to their bees, caused by the deforestation of the Maya forest for the benefit of intensive corn and soybean cultivation, which requires the massive use of chemical pesticides.

An investigation of the phenomenon led us to the discovery of an ancient, sacred species of bee, endangered until recently, but which has since experienced a renaissance: the extraordinary melipone.

Ah Muzen Kaab, deity of life
Melipone bee - Melipona beecheii, mainly; there are about forty varieties - has no stinger; it does not sting. She is very sociable and she rarely gets angry since, as the Maya say, she has become accustomed to humans over millennia.

Divinity of life, Ah Muzen Kaab (in Maya), peaceful and benevolent, is also that of writing, the calendar and medicine. The ancient Maya used its honey as a remedy during rituals, but they also consumed it in the form of sugar or fermented drinks. They raised these sylvan bees in pieces of tree trunks and, hundreds of years later, they still do, but they prefer square hives, which are more convenient to open or close.

A little smaller than the European bee (Apis mellifera), the melipone produces 1 liter of honey per year, compared to 35 for the common bee, which explains why, in the 19th century, Mayan beekeepers abandoned it for bees.

A blonde with blue eyes

The workers have blue eyes, while the queen and the males have black eyes. There is only one guard at the entrance of the hive, a hole of less than a centimeter, which disappears with each entry or exit. Their broods are superimposed circular rays which recall - or inspired, some say - the Maya for their pyramids.

Honey is found in small bubbles or amphorae; it is harvested with a syringe to keep it pure. Like honey, propolis (a kind of mortar) would have medicinal properties that should still be seriously studied.

This is what biologist Aurora Xolalpa is beginning to do in her brand new laboratories at the Mayan Intercultural University of Felipe Carrillo Puerto, in the state of Quintana Roo. The students who work in the apiary and the laboratories will be future researchers or beekeepers of melipones, quite simply.

This is the case of Fani Arguello, from Mani, Yucatan, who studied at this university before embarking on melipone beekeeping in his vast garden, his abundantly flowering milpa.

Mayan honey got lost. We are rescuing the honey bees; they are on the verge of extinction, says Fani Arguello. But that could be changing.

The rebirth of the melipone

At the origin of this rebirth: a Frenchman, Stéphane Palmieri, hotelier in Tulum, in Quintana Roo, and beekeeper since childhood. He went in search of ancestral melipone hives, he found three of them and he began to reproduce them.

The idea was to reproduce colonies in order to be able to multiply them. We needed a somewhat substantial genetic heritage. We reproduced lots of colonies that we distributed in Mayan communities, says Stéphane Palmieri.

It is now necessary that the honey and the products of the melipone be recognized, as well as its millennial cultural and heritage value. And also that the species be protected from deforestation, cultivation-sometimes transgenic intensive and pesticides; like all the bees of Yucatan, for that matter.

All bees are endangered

This was the starting point of our investigation. South of the Yucatan Peninsula is the state of Campeche. Between 2010 and 2020, the peninsula lost more than 80,000 hectares of forest, according to Global Forest Watch, more than half of which in this state, in favor of corn and soybean fields.

Some 80% of this land is exploited by colonies of the Mennonite sect who fled Manitoba in the early 20th century and then the state of Chihuahua in the 2000s for fertile, well-watered and cheap.

The community, however, clashed in 2012 with beekeepers in the region who accused it of carrying out excessive deforestation, practicing transgenic crops and using pesticides. They ended up winning the ban on transgenic seeds, but this is not respected.
Our agricultural practices questioned

When you lower their immune defenses with neonicotinoids, you have everything you need to decimate entire colonies. "It would therefore be an accumulation of factors that would weaken the bees, at the risk of killing them.

But where are our drones?
With the decline of honeybees, how can pollination be ensured? Some say we just have to turn to wild bees. The problem is that even they are threatened!

A European study claims that among the five most effective pollinators, three are bumblebees.

Bumblebees are wild social bees. They are larger, more colorful, hairier than honey bees. There are 250 species in the world, while in Canada, there are about forty. In California, Robbin Thorp has spent his life studying wild bees. "In the early years, most species were doing very well, and suddenly two of them started to decline before my eyes," he says.

In Canada, one-third of bumblebees declined during this period. In North America, at least four species are in danger of extinction, and their number could climb to seven. In Europe, 46% of bumblebee species are in decline, and several are in danger of extinction.

Scientists are struggling to explain the situation. Pesticides such as neonicotinoids find themselves in the dock. The intensification of agriculture that would destroy their habitat would not be unrelated to the decline in population either. Climate change too.

The role of the queen is crucial. Without it, there is no colony. Artificial insemination makes it possible to cross a preselected male with a predetermined queen to reinforce certain genetic traits. In the natural state, "the queens will fertilize with about twenty, thirty males. With insemination, we are able to shrink the thing. The goal is to have a superior quality queen. But the artificial insemination of the bee to produce a super-bee alone cannot ensure the survival of the species.

"I don't think we'll ever be able to develop a bee that is able to tolerate synthetic molecules. I don't think we'll be able to live in intensive culture media for six months in a year, So why not think of a way to change our eating habits, our production methods instead." -

One thing is certain. By modifying our ways of doing things, it is not only the honey bees that benefit, but also the wild bees.

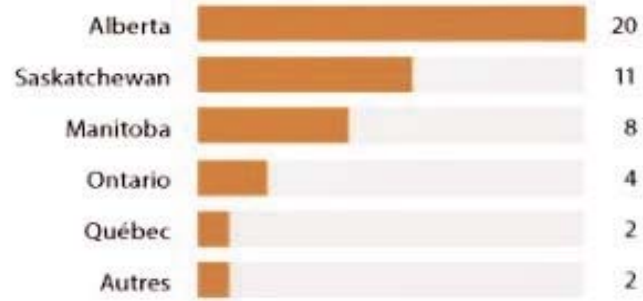
But let us remember that any operation aimed at protecting a natural site, as well as an animal or plant species, is an acknowledgment of failure.

L'industrie du miel au Canada

CANADA	8125 apiculteurs	*pour*	600 000 ruches
QUÉBEC	305 apiculteurs	*pour*	50 000 ruches

Production annuelle au pays

(en millions de kg, en 2012)

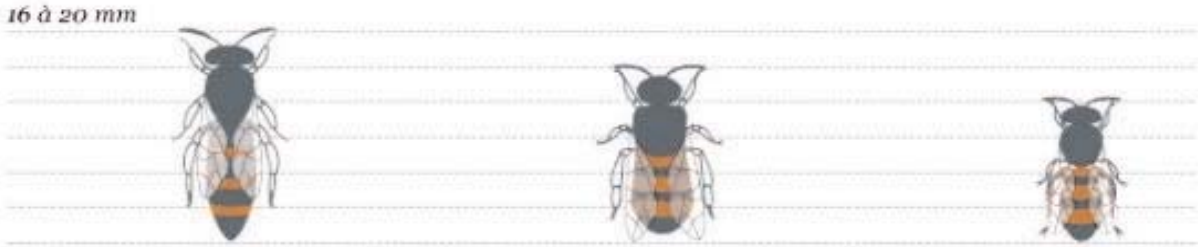


Consommation de miel

(en kg par personne, en 2007)

0,82	1,05
CANADA	QUÉBEC

Les abeilles sont très sociales…



La reine

- La reine est la plus grosse : elle mesure de 16 à 20 mm
- Son abdomen pointu se termine par un organe de ponte
- Une reine pond jusqu'à 2000 œufs par jour
- La reine est fécondée par les faux bourdons et vit de 3 à 5 ans

Les faux bourdons

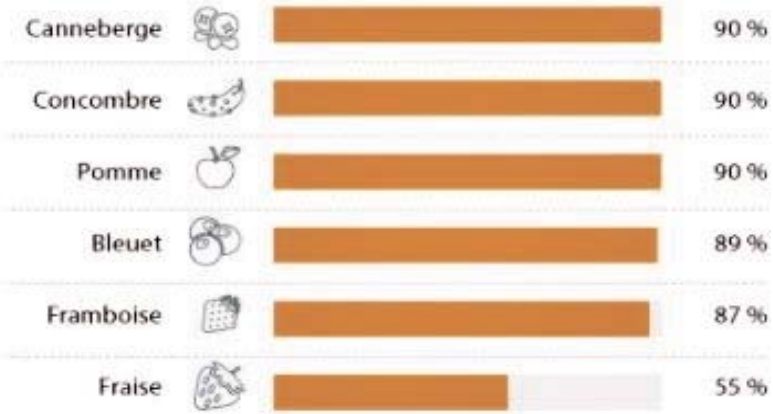
- Les faux bourdons sont les mâles et vivent d'un à deux mois
- Le sort des mâles est différent puisqu'ils meurent soit après l'accouplement soit à la fin de l'été s'ils ne se sont pas accouplés. Ils sont alors chassés de la ruche par les ouvrières qui cessent de les nourrir

Les ouvrières

- Les ouvrières sont toutes des femelles
- Leurs pattes sont munies de structures spécialisées pour la récolte et le transport du pollen
- Elles vivent en moyenne de 6 à 8 semaines et produisent environ 0,8 g de miel dans une vie

… et elles ne font pas juste du miel!

L'abeille domestique joue un rôle crucial en contribuant en très grande partie à la pollinisation de plusieurs fruits.



Source : Fédération des apiculteurs du Québec

03-26
Puntius nigrofasciatus
2
5000
BANKY FOIBEN'I MADAGASIKA
FRANCS
Cethosia nietneri nietneri
ரூபியடி டெகெயி
இரண்டு ரூபாய்

DISAPPEARANCE OF BIRDS

Isn't it strange to think that dinosaurs still exist in some form on our Earth? Birds are indeed their closest descendants, although the passing centuries have generated a multitude of evolutions.

A horny, toothless beak gradually took the place of a jaw that once had sharp teeth, while the bones of their wings fused over time, where several clawed fingers had originally been hidden.

Essential for flight, camouflage but also for maintaining an optimal body temperature, it is these feathered wings that today represent one of the most distinctive features of birds although all, like the ostrich, do not not have the ability to fly. A few rare species, such as the kiwi, are even totally devoid of it!

Warm-blooded oviparous vertebrates with a generally hollow skeleton, birds currently include nearly 11,150 species divided into about thirty different orders. Since they are found practically everywhere throughout the world and their habitat has a major influence on their behaviour, all of them have morphological or social specificities adapted to their way of life.

There are those who have learned to resist the freezing cold of the polar regions, where others brave the extreme temperatures of the hot deserts of our planet on a daily basis. There are large carnivores and small seed-eating species, while still others, accustomed to aquatic environments, know how to distinguish the small particles that make up their meals in the mud.

Whether they are migratory or not, birds play a major role in biodiversity, whether it is plant pollination, seed dispersal or the regulation of insect species. harmful.

One in eight species is however today threatened with extinction and the situation is particularly worrying in France where the countryside has been emptied of a third of their birds in the space of 15 years. At the heart of the problem, ever more intensive agriculture, which adds to the urbanization, pollution and hunting already observed.

Recent studies carried out by the CNRS and the Museum of History have come to an alarming conclusion: in 25 years, a third of birds have disappeared in agricultural areas, with an acceleration in 2016 and 2017.

The causes of his disappearance are multiple. A bird needs food and shelter to live. Urbanization and deforestation make it difficult to find the nesting place.

Disappearance of wastelands
The wastelands have given way to industrial areas, hypermarkets or housing estates. The destruction of the hedges which served as refuges and pantries did not improve the situation.

Disturbing hobbies
Some hobbies cause disturbances, all-terrain vehicles, bicycles, climbing or other, and scare birds away from these places. The barn swallow is a good example since half of the European population disappeared, finding no barn or insects.

Nests that get in the way
In some towns the nests are destroyed because of the soiling caused. Same situation for the goldfinch and the greenfinch which were common in the past.

Disappearance of insects
For the cover, the problem is more serious. All birds need a protein supply especially when they are young. The latter, they find them in insects. The small crops that once served as food resources for the winged people have given way to intensive crops. Their demands have eradicated insect populations. They appeared with their wide open spaces and their pesticides. Most of the critters have disappeared, no more insects, no more birds. Worse, some have been poisoned by their food. Neonicotinoid insecticides are singled out.

They have an impact on the food resources of many bird species. They can act directly on them by poisoning following consumption of treated seeds, that is to say coated with the toxic substance before being sown. Herbicides such as glyphosate are also incriminated. In 2009, the common agricultural policy put a stop to fallow land, which is also harmful for biodiversity.

Invasive species
Another recent phenomenon is impacting the bird population: the appearance of invasive species such as rose-ringed parakeets. The latter have gradually taken over the Ile de France and other departments. Appearing in the 1970s, this cave species competes with others such as tits, nuthatches, woodpeckers or even red squirrels, for their nesting which takes place from January to April. First come, first served, others will look elsewhere.

Fearsome predators
Last but not least, the predation of domestic cats, which are formidable predators, and their impact is much greater than it seems, not to mention the other small animals in the garden.

It's hard to be a bird nowadays, the robin, the blackbird, the titmouse are always close to us but for how long if we do nothing? It would be a shame if the only possible sighting was to see them stuffed on a plastic branch in a museum.

LES OISEAUX DE PLUS EN PLUS MENACÉS

www.especes-menacees.fr

11 121

C'est le nombre d'espèces d'oiseaux existantes

EVOLUTION DES POPULATIONS D'OISEAUX DANS LE MONDE

- 44 % — *Populations stables* — 4 392 espèces
- 40 % — *Populations en déclin* — 3 967 espèces
- 8 % — *Données insuffisantes* — 823 espèces
- 7 % — *Populations en croissance* — 653 espèces

PRINCIPAUX GROUPES D'OISEAUX EN DÉCLIN

LES VAUTOURS

68 % des espèces de vautours sont menacées

95%

des vautours d'Asie du Sud ont disparu entre 1991 et 2000. La cause principale de cette disparition est l'empoisonnement

LES GRUES

73 % des espèces de grues sont menacées

LES ALBATROS

68 % des espèces d'albatros sont menacées

LES PERROQUETS

29 % des espèces de perroquets sont menacées

PRINCIPALES MENACES QUI PÈSENT SUR LES OISEAUX

MISE À JOUR DE LA LISTE ROUGE DES OISEAUX

www.especes-menacees.fr

11 121 espèces d'oiseaux sont recensées dans le monde

1 460 espèces sont menacées soit **13%** de tous les oiseaux

787 VU · 448 EN · 225 CR

« 742 nouveaux passereaux ont été découverts

11 % de ces espèces sont déjà menacées

13 sont déjà éteintes... »

QUELQUES BONNES NOUVELLES

Bouvreuil des Açores — CRITIQUE → VULNÉRABLE

Oriole de Montserrat — CRITIQUE → VULNÉRABLE

Zosterops modestus — EN DANGER → VULNÉRABLE

ET D'AUTRES, MOINS RÉJOUISSANTES...

Perroquet gris du Gabon — VULNÉRABLE → EN DANGER

Garrulaxe à front roux — EN DANGER → CRITIQUE

Bulbul à tête jaune — VULNÉRABLE → EN DANGER

Etourneau pie de Java — INCONNU → CRITIQUE

Mainate robuste — INCONNU → CRITIQUE

Etourneau à ailes noires — INCONNU → CRITIQUE

BANQUE NATIONALE DU RWANDA
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THIS NOTE IS A LEGAL TENDER FOR TEN DOLLARS SUBJECT TO THE PROVISIONS OF SECTION 3588 R.S.
DOLLARS
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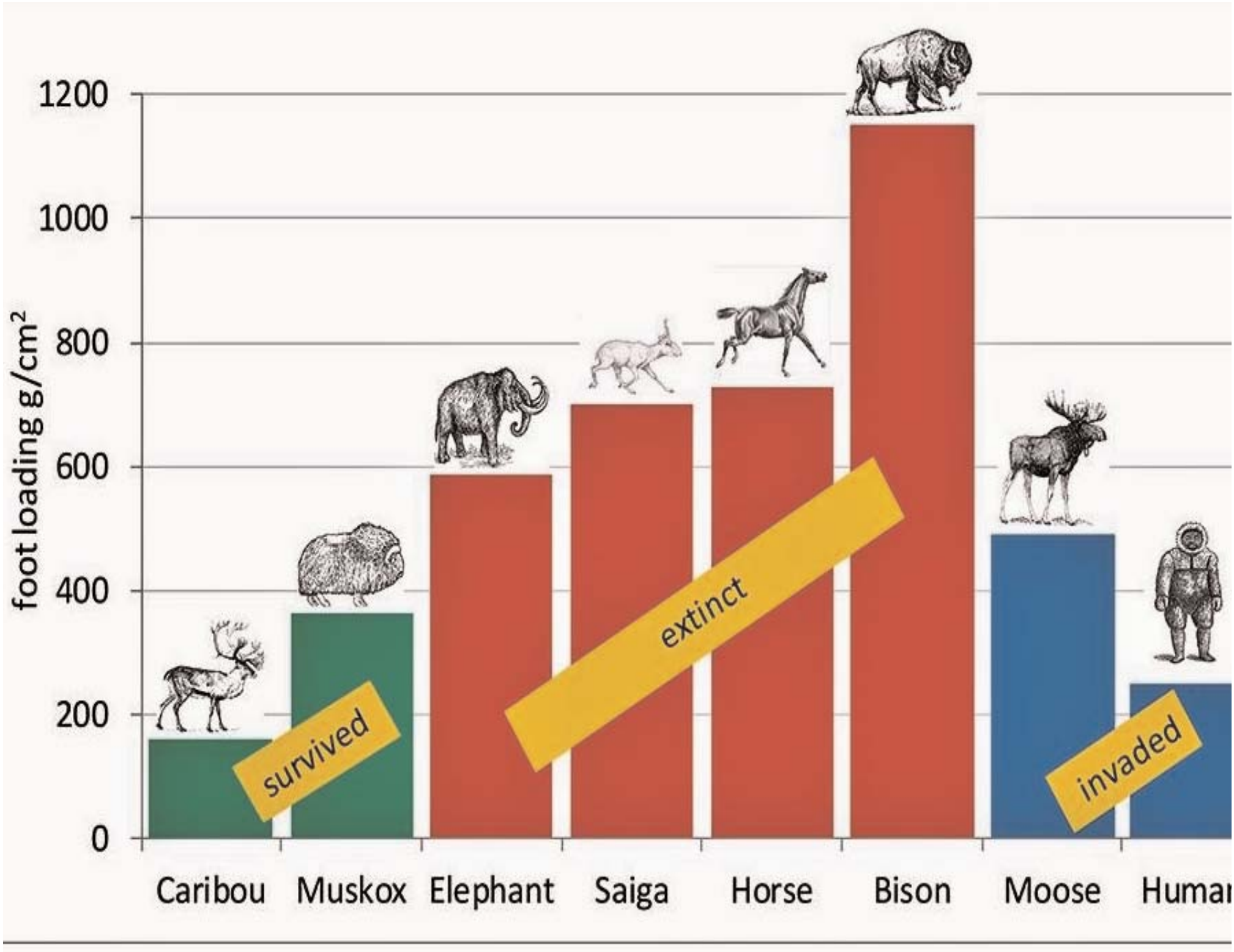
ONE THOUSAND
NGAN-HANG QUOC GIA VIET-NAM
500


1200
1000
800
600
400
200
0
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extinct
invaded
Caribou
Muskox
Elephant
Saiga
Horse
Bison
Moose
Human

Disappearance of mammals

In 40 years, half of wild animals have disappeared because of man, according to the WWF. Thus, the population of wild vertebrates would have decreased by 52% between 1970 and 2010. More than 10,000 species have been studied to obtain this sad figure.

This is a new alarm signal that has just drawn the WWF. Like every two years, the organization unveiled its Living Planet Report and the latest figures are simply frightening. According to this report, the Earth would have lost 52% of its wild fauna of vertebrates between 1970 and 2010.

A heavy trend of which the man would be the main responsible and which would give "no sign of slowing down", affirms the report taken up by AFP. Thus, the text denounces in particular the presence of a level of carbon in the atmosphere unequaled for more than a million years and its serious effects on climate change and ecosystems.

More than 10,000 species closely monitored
To establish its conclusions, the Living Planet report is based on three areas. The populations of more than 10,000 species of vertebrates (mammals, birds, reptiles, amphibians and fish) have thus been scrupulously studied to understand their evolution. "There is a lot of data in this report and it may seem unmanageable and too complicated," admits WWF chief scientist Jon Hoekstra.

But "the clear trends we see are uncomplicated: 39% of terrestrial wildlife has disappeared, as have 39% of marine wildlife and 76% of freshwater wildlife. All of this in 40 years." , he explains. According to the data, the most affected areas are Latin America (-83%), followed closely by the Asia-Pacific region.

However, the decline is much more marked than in previous reports, due to changes in the method of calculation which offer a more faithful representation of the global distribution of vertebrate species, specifies the NGO. Thus, in the last report dating from 2012, it concluded that there was a 28% drop in wild species between 1970 and 2008. At that time, the index only covered 2,699 species.

A man-made decline

For the WWF, man and his activities are the cause of this sharp decline. The causes cited are habitat loss and degradation, hunting and overfishing, and climate change. In its report, the organization looked at the impact of man on his environment, in particular in terms of greenhouse gases and the consumption of goods.

But she was also interested in the limits of biocapacity, that is to say the quantity of resources available in water, food and sequestered carbon. "Today, we need the generating capacity of one and a half Earths to have the ecological services that we enjoy every year", comments the WWF. Also, if man is the main responsible for the decline of animals, this will not be without consequence for him.

Currently, 60% of natural resources and services are in decline. This includes everything that is exploited in the seas and forests. "We are gradually destroying the ability of our planet to support our lifestyle," said WWF President Carter Roberts.

While the world population will continue to increase (9.6 billion inhabitants in 2050 and 11 billion in 2100), the biocapacity of each one will continue to decrease, further aggravating the problem.

Des animaux en voie de disparition

Dans le monde...

Dans le monde, les **5 continents** sont concernés par les disparitions d'espèces. En **Afrique**, de **grandes réserves** ont été créées et **la chasse y est interdite**. Des **zones protégées** existent aussi dans certains océans, pour empêcher la pêche des baleines par exemple.

LES DIX ESPÈCES LES PLUS MENACÉES SELON WWF
en 2010
CAUSES
Chasse/pêche
Trafic
Destruction de l'habitat
HABITAT
Basse végétation
Forêt
Zone habitée
Zone côtière
Plaine sèche
GORILLE des montagnes
(Gorilla beringei)
380 individus
CACATOÈS à ventre rouge*
(Cacatua haematuropygia)
950 à 1 200 individus
PANDA géant
(Ailuropoda melanoleuca)
1 000 à 2 000 individus
TIGRE du Bengale
(Panthera tigris)
3 200 individus
ÉLÉPHANT d'asie
(Elephas maximus)
40 000 à 50 000 individus
TORTUE à nez de cochon
(Carettochelys insculpta)
Grand REQUIN BLANC
(Carcharodon carcharias)
GECKO à queue feuillue
(Uroplatus fimbriatus)
NAPOLÉON
(Cheilinus undulatus)
DAUPHIN de l'Irrawaddy
(Orcaella brevirostris)
LES ESPÈCES MENACÉES
par classe
41 %
25 %
13 %
Amphibiens
Mammifères
Oiseaux
LES ESPÈCES VICTIMES DU COMMERCE ILLÉGAL
Nombre d'individus par an
Poissons
100 millions
Oiseaux
1,5 million
LE PRIX DE LA CORNE DE RHINOCÉROS
44 000 euros le kilo

BANKY FOIBEN'I
500
DIMAN JATO ARIARY
НАРОДНА БАНКА НА РЕПУБЛИКА МАКЕДОНИЈА
10
SURINAME
MUNTBILJET
GULDEN
UITGEGEVEN KRACHTENS WET
VAN 8 APRIL 1960 (G.B. No.38)
X/3 070701
RESERVE BANK OF
NEW ZEALAND
DOLLA
BANCO DE LA REPUBLICA
BOGOTA COLOMBIA
1
PESO
ORO
10
SEYCHELLES
MONETARY AUTHORITY
A000563
2
BANK OF PAPUA NEW GUINEA
LEGAL TENDER
THROUGHOUT
PAPUA NEW GUINEA
GOVERNOR
SECRETARY
DEPARTMENT OF FINANCE
AKJ 001761
3

Massive extinctions also concern the oceans: an American study warns that beyond two degrees of warming, we could witness the disappearance of marine species such as we have not seen for more than 250 million years.

Ocean life could suffer a mass extinction, like those that decimated marine animals in the past, the meteor that killed the dinosaurs 66 million years ago or the gigantic volcanic eruptions that would have triggered 252 million years ago, the greatest ecological disaster in the history of the Earth ("The Great Dying", "the great agony", as the Anglo-Saxons call it). It is the latter, officially known as the Permian-Triassic extinction, which has today become the sad benchmark for mass extinctions. It has indeed seen the disappearance of up to 96% of marine species and two-thirds of terrestrial life, and is often presented as the moment when life could have died out on our planet.

It is to this Permian-Triassic extinction that Justin Penn and Curtis Deutsch, researchers in the Department of Geosciences at Princeton University, refer today to a study published in the journal "Science", which brandishes the specter of a new massive extinction… under the waters.

"In the most important of these events, the 'great agony' at the end of the Permian, the loss of more than two-thirds of the genera of marine animals reduced biodiversity almost to its minimum since the animals dispersed ", write the two scientists.

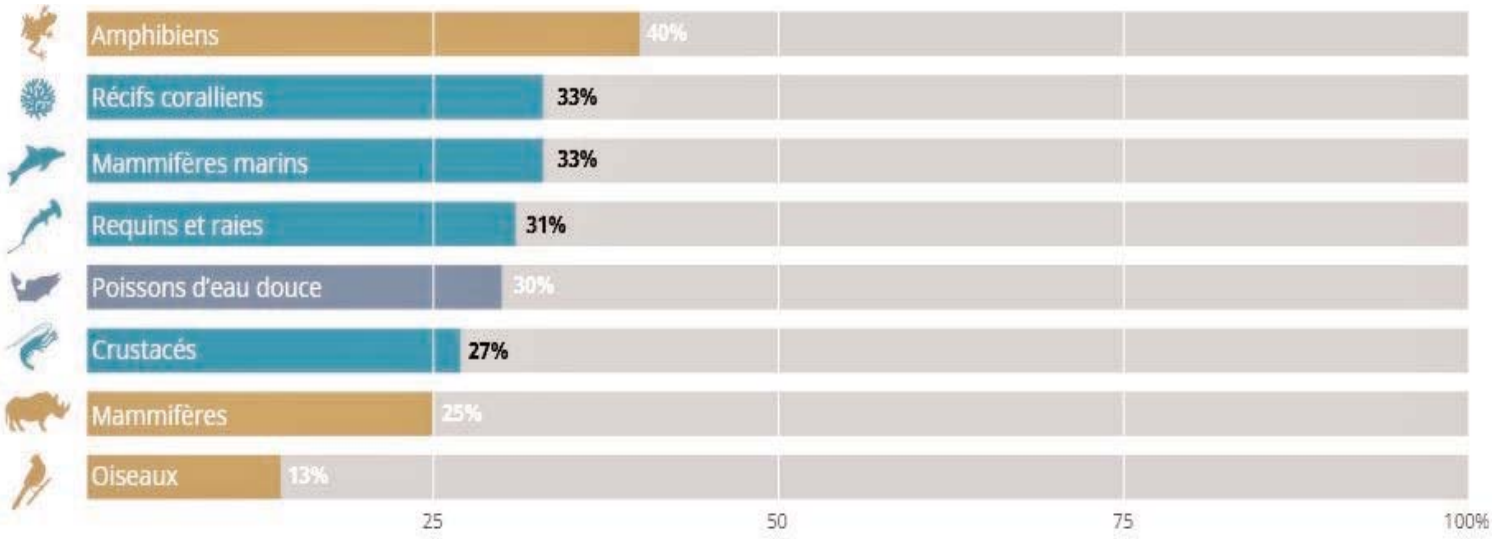
"Environmental changes similar to those of the late Permian, including rising temperatures and declining biodiversity.

A survey by the World Wide Fund for Nature, WWF, suggests that half of marine animal populations disappeared between 1970 and 2012 due to human activity.

Fish and other marine species are particularly threatened by human activities and their extinction rates are much higher than those of terrestrial species such as birds and mammals. Today, 40% of amphibians, 30% of freshwater fish and more than 30% of coral reefs and marine mammals are endangered. Nearly half of them, 49% to be more precise, would have disappeared in forty years, barely more than a generation. A finding that is alarming to say the least.

Marine species are the most threatened

Proportion of terrestrial, freshwater and marine species threatened with extinction



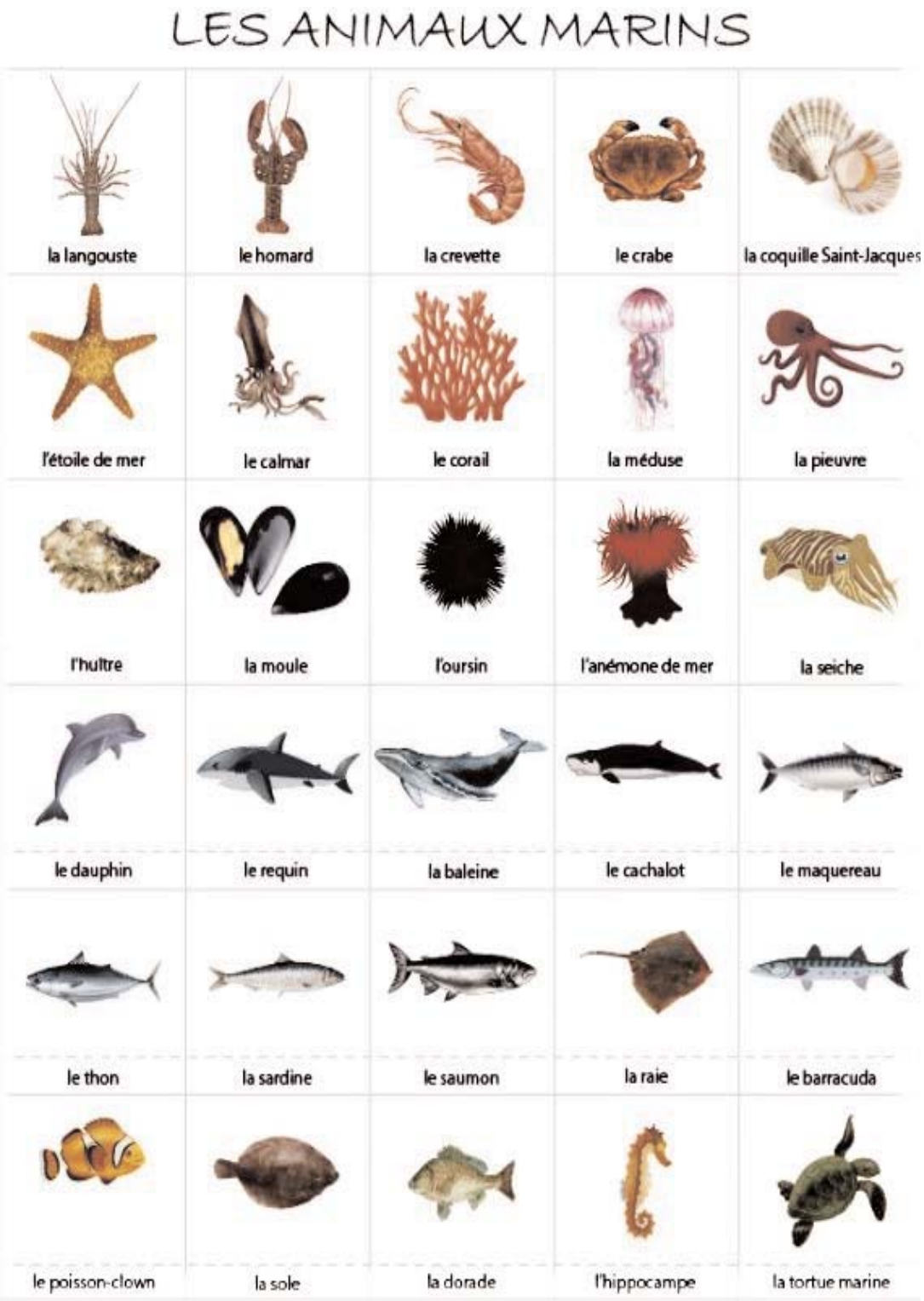
Source: Global Assessment Report on Biodiversity and Ecosystem Services (IPBES); IUCN 2020. The IUCN Red List of Threatened Species. Version 2020-2. www.iucnredlist.org. Downloaded on 28 July 2020.

The conclusions of the survey are based on all oceanic animal species belonging to the fish family, but also mammals, reptiles and birds. The trends in their evolution have been highlighted by analyzing a database of observations of 5,829 populations belonging to 1,234 species.

Unsurprisingly, the cause of this worrying decline is human activity. In a press release, the WWF denounces a combination of several factors:

From overfishing and extractive industries to coastal development and pollution, to greenhouse gas emissions responsible for ocean acidification and warming seas. And unfortunately it doesn't seem to be getting any better. In just a few years, fish have become a particularly prized resource on a global scale. Their average per capita consumption fell from 9.9 kilograms in the 1960s to 19.2 kilograms in 2012.

Each year, nearly 1.5 million tonnes of fish are harvested in the Mediterranean. As a result, these historic fishing grounds around the world have lost nearly 90% of their stocks. This trend is observed in all the seas and oceans of the world. Nearly 75% of the stocks of certain commercially traded fish families, such as tuna and mackerel, have already disappeared.



LIFESTYLE

Everywhere we will eat more, and of everything

The distribution of the different food categories should be more or less the same in 2050, with, however, a sharp global increase in animal consumption increasing the number of calories consumed, favoring a growth in obesity.

Ration alimentaire

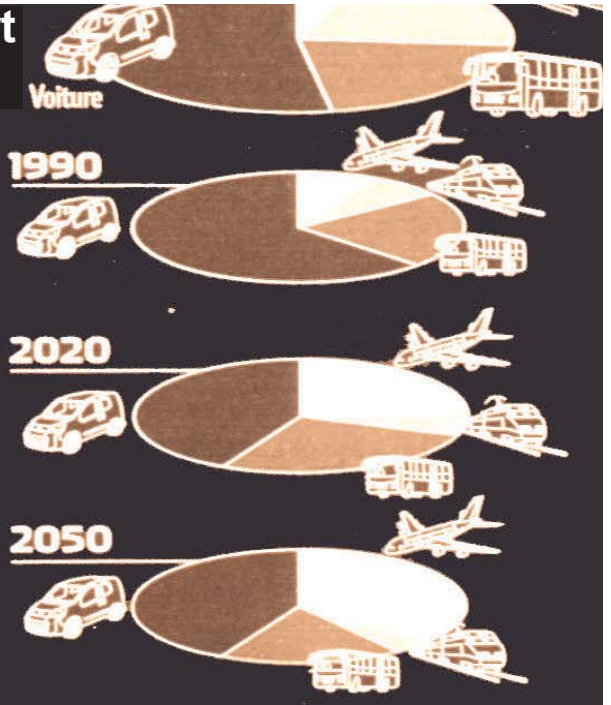
1969 -1971

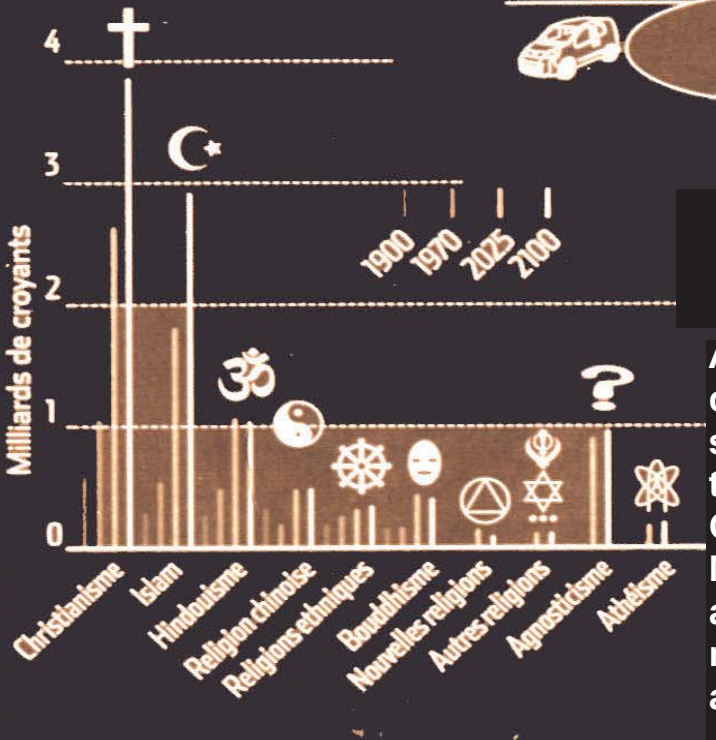
2373

kcal/hab/jour

A boom in air transport

Since 1960 and until 2050, all modes of transport continue to increase in absolute value. Aviation will be greatly favored in the future to the detriment of road transport.



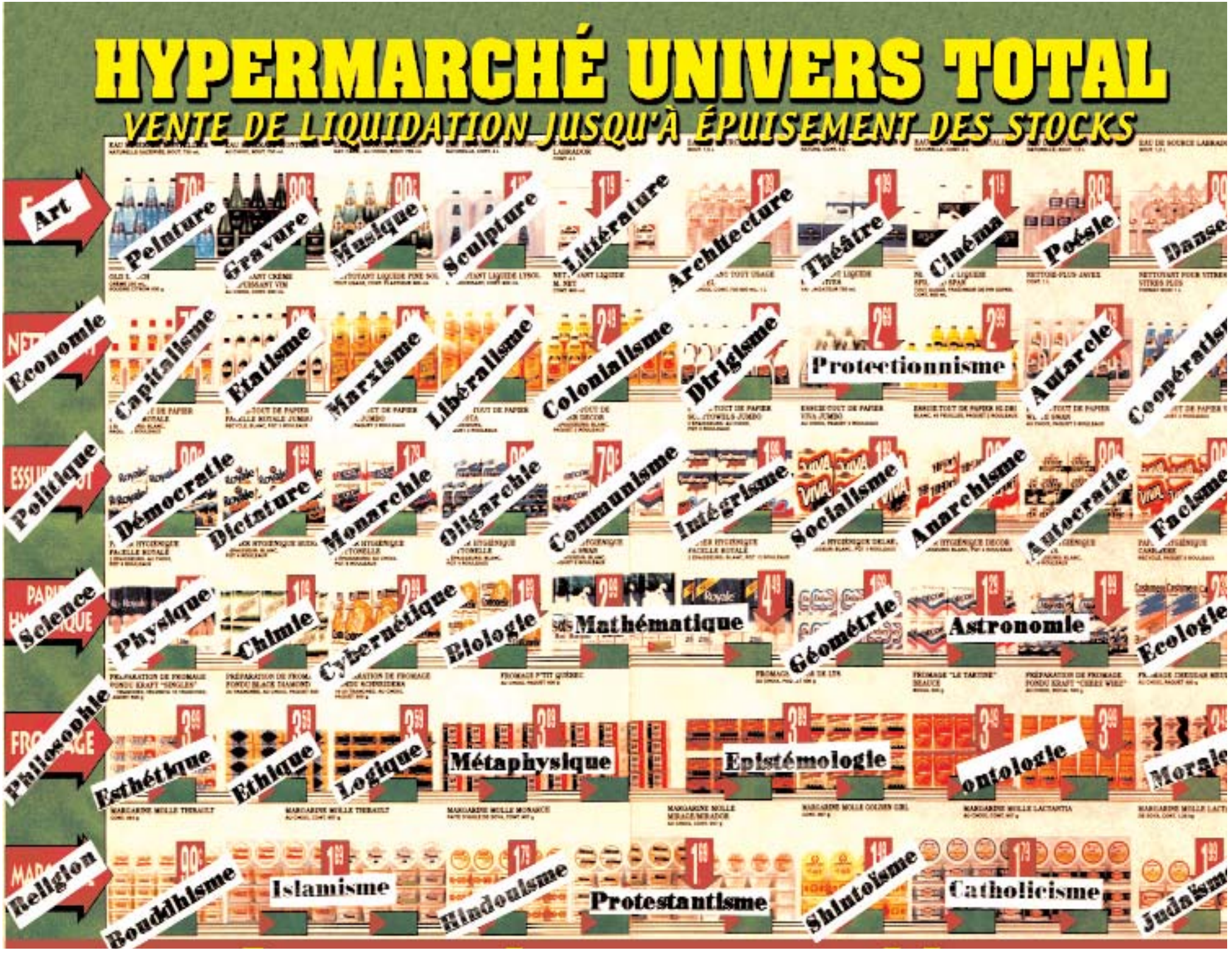


More and more believers

According to the demographic data, a significant increase in the number of Christians and Muslims is predicted and a decrease in the number of atheists and agnostics.

10 476

It is in kilometres, the annual distance traveled per inhabitant in 2050. It was 1814 hm in 1960 and 4382km in 1990


HYPERMARCHÉ UNIVERS TOTAL
VENTE DE LIQUIDATION JUSQU'À ÉPUISEMENT DES STOCKS
Art
Peinture
Gravure
Musique
Sculpture
Littérature
Architecture
Théâtre
Cinéma
Poésie
Danse
Economie
Capitalisme
Etatisme
Marxisme
Libéralisme
Colonialisme
Dirigisme
Protectionnisme
Autarcie
Coopératisme
Politique
Démocratie
Dictature
Monarchie
Oligarchie
Communisme
Intégrisme
Socialisme
Anarchisme
Autocratie
Fascisme
Science
Physique
Chimie
Cybernétique
Biologie
Mathématique
Géométrie
Astronomie
Ecologie
Philosophie
Esthétique
Ethique
Logique
Métaphysique
Epistémologie
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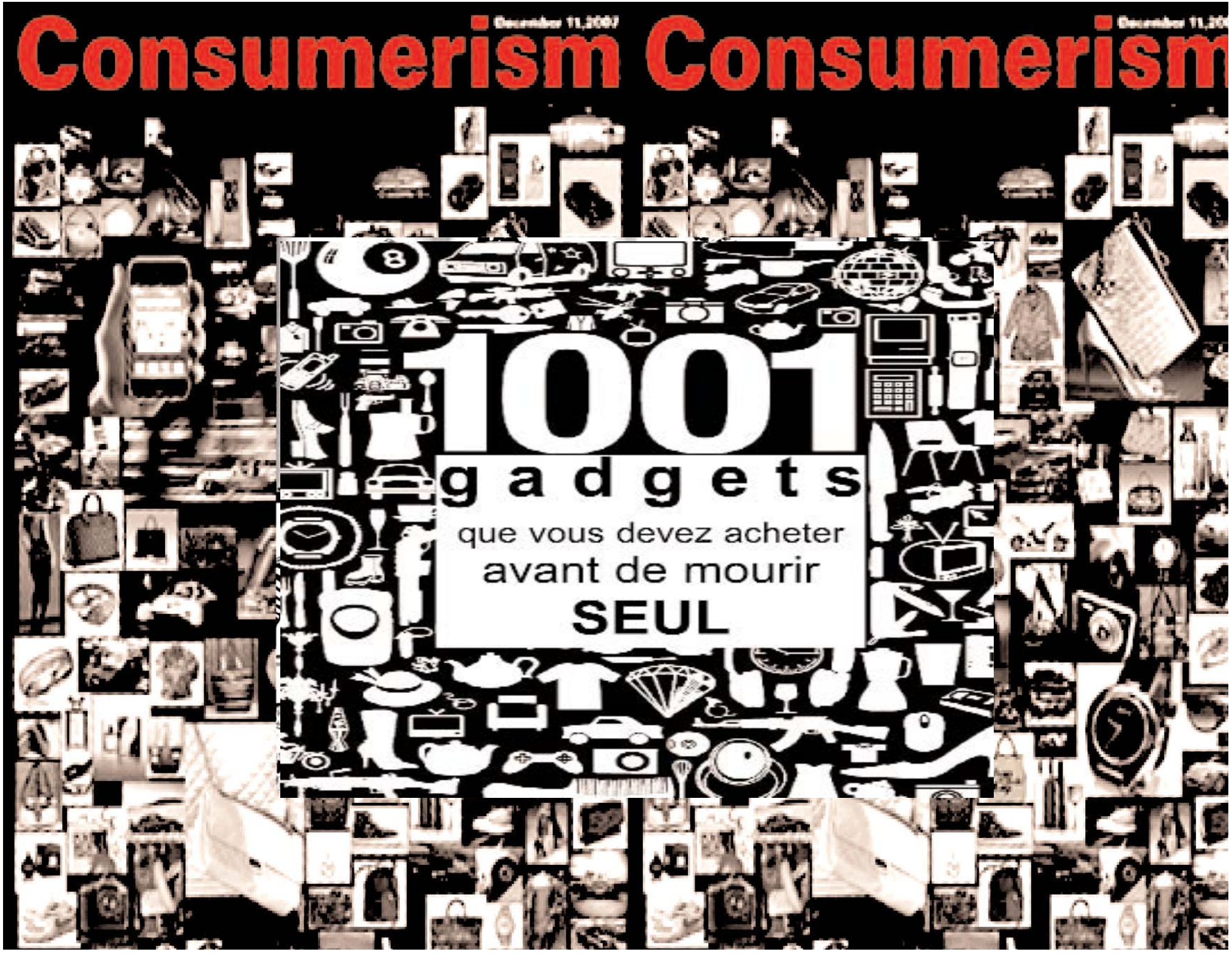
Islamisme
Hindouisme
Protestantisme
Shintoïsme
Catholicisme
Judaïsme


Consumerism Consumerism
1001
gadgets
que vous devez acheter
avant de mourir
SEUL

Consumption

Our bad habits of consumption would be in question. Some examples are sometimes more telling than the theory. We pay particular attention to the beauty of the fruits and vegetables we buy, eliminating any that show signs of staining or deformity. But do they taste bad? In the end, distributors must throw away food that does not meet our expectations and, above all, refuse agricultural products with imperfections. Thus, while our country is the leading European agricultural producer, some farmers throw away 20 to 30% of their production, which is nevertheless edible, every year.

Mismanagement of expiry dates is to blame (why put one on non-perishable dry goods), but it doesn't explain everything. Another habit is not without consequences: our fruits and vegetables are, for example, stored at the bottom of refrigerators, where it is coldest. However, some of them, such as cucumbers, do not like low temperatures. They degrade faster, while having a better chance of ending up in the garbage.

Full rays at any time of day

In France, the few thousand hypermarkets would eliminate approximately 850 million euros of food per year, a figure six times higher than the annual budget of the Restos du Coeur. However, this organization serves more than 100 million meals a year! Fruits and vegetables are not the only ones affected by these figures. Many distributors would indeed exceed consumer expectations by throwing away all imperfect products, for example a pack of cans that has fallen on the ground and whose packaging has torn. Some waste, such as fruit and vegetables, could be recovered, but this is not the case. Indeed, discarded food can no longer be used to feed animals since the mad cow crisis.

About 15% of bananas produced in Ecuador are discarded locally for aesthetic or economic reasons. The others are transported by boat to Europe (12 days of travel) where they will be placed in a ripening room for 8 to 10 days. They will be put on sale 22 days after their harvest… and thrown away after 96 hours only if no one buys them.

About a third of our bananas come from Ecuador, a country where 146,000 t of this fruit are thrown away each year, even before being loaded on a ship, for aesthetic and economic reasons. The criterion of beauty does not explain everything. In India, food waste is mainly due to logistical problems, for example following the use of poorly adapted transport techniques.

This country produces largely enough to meet the needs of its population. One in five inhabitants suffers from malnutrition. Moreover, each Indian household wastes annually, in financial terms, respectively four and six times less than a French or American household. As for the United States, they alone could feed two billion people with the foodstuffs that are thrown away each year (estimated cost of 100 million dollars per year)! The mess is massive and global.

Another practice of large retailers is also called into question: the shelves must always be full, including the one offering breads and pastries. However, those that are not sold in the evening are necessarily thrown away. And it takes 1,000 liters of water to produce one kilogram of flour... In other words, the equivalent of a tub of water would be wasted every time a baguette is put in the trash.

THE FUTURE IS
KAPITALISM
WASHINGTON'S NEW ROLE IN BANKING IS JUST THE BEGINNING OF THE 'PUBLIC-PRIVATE' WORLD TO COME
MANIC
DEPRESSIVE
ECONOMY
THE FUTURE OF
KOMMUNISM

Colorful capitalism
CONSUME
MORE
WEAR A
STAR
AND BE A
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HEINZ
BAKED BEANS
AT&T
Texaco
Lockheed
Volvo
Fujitsu
Hitachi
CANAD
Renault
Fiat
Mitsubishi
Goodyear
Philip Morris
Boeing
Westinghouse
Siemens
Nabisco
Daimler-Benz
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Toyota
Electrolux
THE UNITED STATES OF AMERICA

BARBARELLA
Coca-Cola
Have a Coke
BEATLES FAN
Campbell's
TOMATO
USA

Biological diversity as a foundation our food and our health.

One million species are threatened. This is the shock summary of the latest report from the experts of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES). The panda, the tiger or even the polar bear may be living their last days on our planet. Wilderness is in danger. We are now all aware of this.

But we are probably even less sensitive to the threat that the loss of biodiversity poses to our food. However, last February, the Food and Agriculture Organization of the United Nations (FAO) published a disturbing report on this subject. A report that focuses on plants and animals, wild or farmed, sources of food - whether for humans or animals - fuel or fiber. But also to all organisms, such as insects, earthworms, fungi, etc., which support food production by maintaining soil fertility, pollinating plants or purifying water, for example.

"Less biodiversity means that plants and animals are more vulnerable to pests, diseases and climatic hazards," says Graziano da Silva, FAO Director-General. And this encourages farmers to use pesticides or antibiotics. Enough to further weaken the animals as much as the soil. In addition to our dependence on a dwindling number of species to feed us, the increasing loss of biodiversity for food and agriculture puts already fragile food security at risk.

Of some 6,000 species of plants grown for food, less than 200 now contribute substantially to global food production. Only nine of them represent 66% of total agricultural production! Some even claim that in a century, 90% of cultivated species would have disappeared. Blame it on pollution, disease, global warming, but also on an increasingly standardized agriculture.

Global animal production is based on around 40 animal species, of which just a handful provide the vast majority of meat, milk and eggs. Of the 7,745 local livestock breeds listed by country in the world, 26% are threatened with extinction. As for the fish stock, almost a third is overexploited and more than half has now reached its limit of resistance. The 17 main fishing grounds in the world are also exploited beyond their sustainable limits.

World food poses a question. For example, will we all be able to eat in 2050? Currently 193 million people are in a situation of extreme hunger in the world, according to the latest alarming report from the FAO, the UN agency for food and agriculture.

"193 million people in food distress is a record figure. Over one year, this represents an additional 40 million people. In six years, the figure has even doubled. What is really worrying are the trends we face in terms of acute food insecurity".

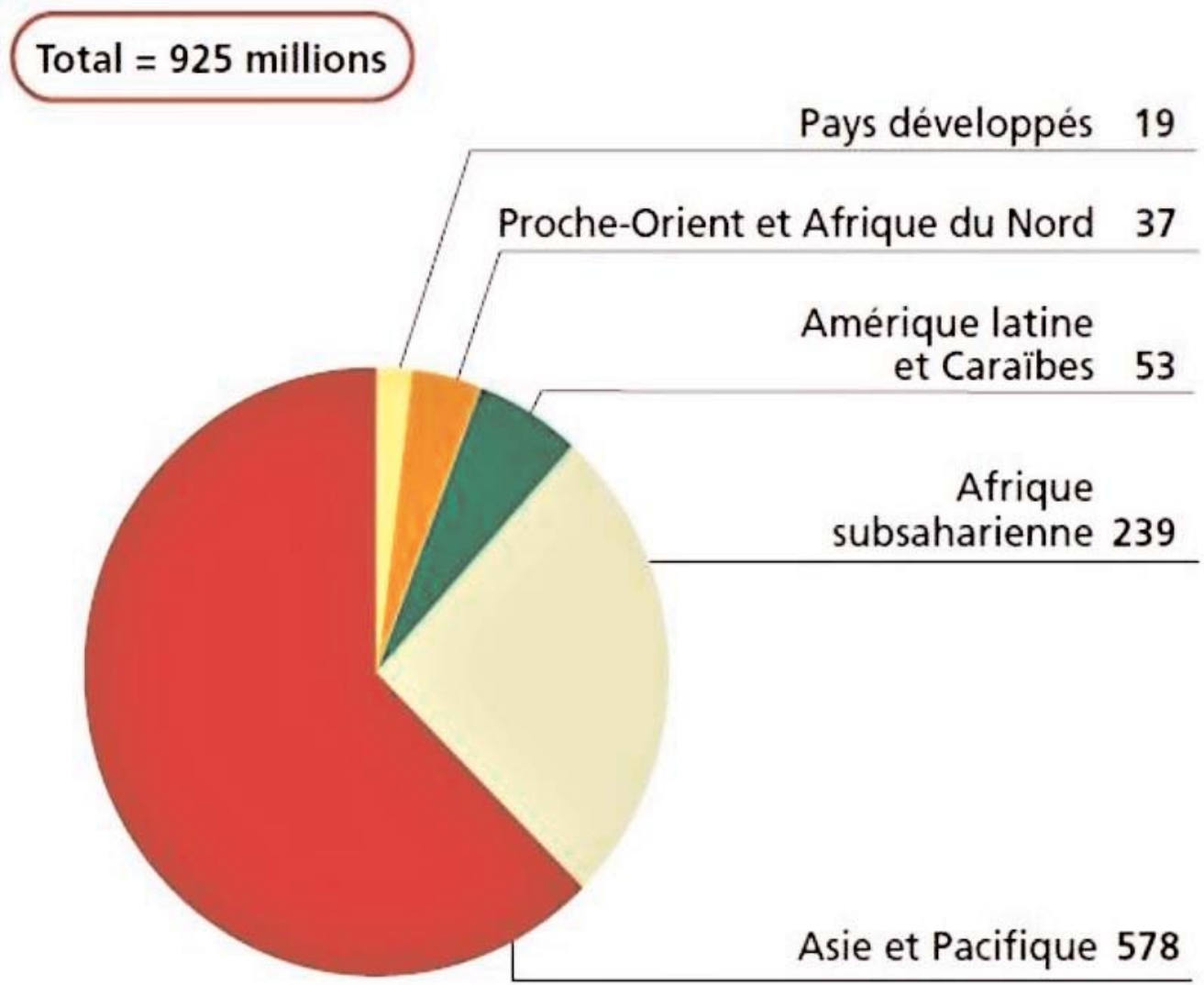
One in two people suffer from malnutrition
Let's look at the current food situation in the world. The balance sheet is rather disastrous. "Approximately 1 billion people are calorically undernourished. To this must be added 1 billion human beings with a lack of trace elements (vitamins, certain metals, etc.). The WHO lists approximately 1.5 billion overweight individuals, which leads to pathologies (obesity, cardiovascular diseases, certain cancers and type 2 diabetes). " The calculation is quickly made: 3.5 billion people suffer from malnutrition on the planet... one in two inhabitants.

The reasons are complex and numerous. "Insufficient income and education explain a lot of this situation. A study carried out in New York shows that we can almost perfectly superimpose the map of poverty and that of obesity." The food supply is also finger pointing. "Food is considered by most politicians and businessmen as a commonplace good that can be industrialized without causing harm. However, this is totally false." Unfortunately, the products developed with this in mind systematically contain too much sugar , salt and fatty substances. "These three excesses and insufficient physical exercises promote foodborne non-communicable diseases."

A more socio-economic problem would be added to these two causes: "the food supply does not arrive in sufficient quantity and quality, or else at inaccessible prices, in developing countries". It would therefore be badly distributed on the scale of the planet despite the existence of globally sufficient resources.

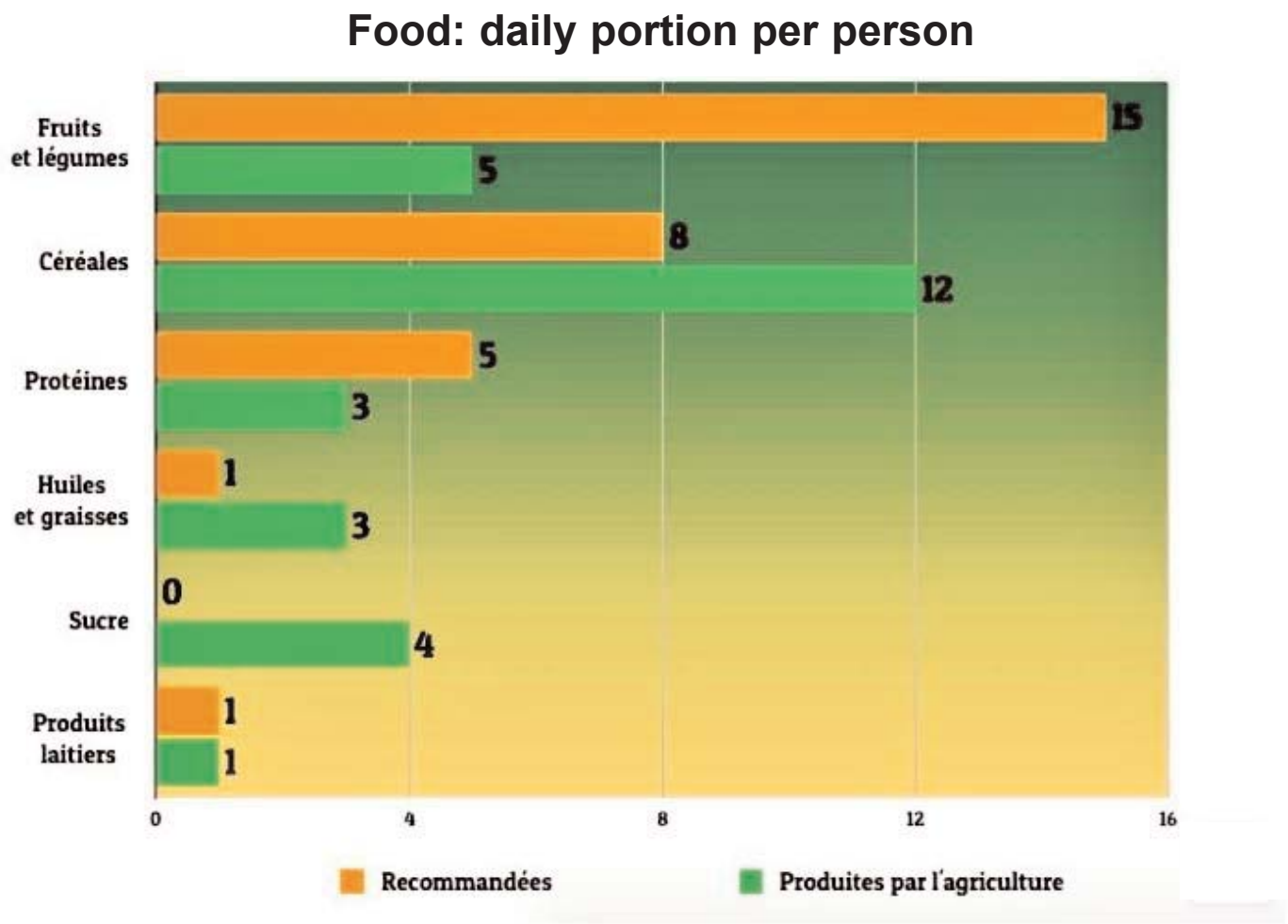
World agriculture today produces the equivalent of 2,750 calories per person per day, more than enough to feed all the inhabitants of the planet. Even taking into account 20% of food wasted during the supply chain, we arrive at 2,200 calories, which is still in theory more than enough. The problem is that this production is completely unbalanced in relation to food needs. Agriculture thus produces the equivalent of twelve daily parts of cereals, five parts of fruit and vegetables, four parts of sugar, three parts of vegetable oils and fats, three parts of proteins and one part of dairy products.

The dietary needs recommended by the Harvard University reference system are eight parts of cereals, fifteen parts of fruits and vegetables, zero sugar, one part of vegetable oils and fats, five parts of proteins and one part of products. dairy (see graph).


Total = 925 millions
Pays développés 19
Proche-Orient et Afrique du Nord 37
Amérique latine et Caraïbes 53
Afrique subsaharienne 239
Asie et Pacifique 578

World agriculture is largely unbalanced: it thus produces three times less fruit and vegetables than what would be needed to feed the seven billion humans according to nutritional recommendations. © Céline Deluzarche, Futura, after Krishna Bahadur KC et al., PLOSOne, 2018

Around 1.5 billion hectares of land are currently under cultivation. According to recent estimates, this figure could increase by 30%, while taking into account the growing influence of cities and industrial and communication infrastructures on the fields. "But the problem of the distribution of world food will remain unsolved if nothing more is done. It is not enough to increase production, it must also be redirected, for example by stimulating agricultural development where the we need it, in the countries of the South, while respecting the environment."



World agriculture is unbalanced: it produces three times less vegetables and fruits than it would take to feed seven billion people according to the recommended standards.

The current economic model must change. "We have to change our values and get back to basics.

Food meets biological needs, but also cultural and social ones. From there, we have to rebuild". The current agri-food system based on profit and individualism is of course targeted. This agri-food capitalism can be replaced by a cooperative economy which thus proposes to develop models based on proximity (short channels, modest-sized factories, etc.) highlighting locally produced agricultural materials.

Scientific research will also have a role to play, in particular to develop more diversified agricultural systems that manage to bring crops, animals and natural environments together. "From the point of view of research, we have all the tools. However, investments must not be made without taking into account the constraints of sustainable development (greenhouse gases, pollution, etc.). We must not either no longer transpose in the countries of the South the methods used in the past in France (agrochemical intensification of crops), even if they have greatly helped us. "

Tomorrow's research will also have to avoid certain excesses and above all take into account an often neglected parameter: social equity. Sources of employment must be preserved. Nearly 500 million farmers feed the world's population. However, if we generalized the current agro-industrial model, only 500,000 agricultural companies each exploiting 4,000 hectares of land would be enough to feed 9 billion people. But what would then become of the peasants of the world?

This "detail" has been overlooked by people wishing to develop urban vertical farms or in vitro meat production. The right solution would rather consist in creating new varieties of plants that can, for example, better withstand periods of drought to cope with ongoing climate change or new techniques to limit soil degradation. A good example is the development of rice capable of growing in soils that are too salty. It will allow Japanese farmers to reuse the 20,000

hectares of agricultural land flooded during the tsunami.

Our food future can therefore be looked at with hope, but on one condition: farmers, industrialists, politicians and consumers will have to make many efforts for change over the long term. The final word goes to Jean-Louis Rastoin: "there is no lack of land, it is rather the political will to do things in a sustainable and responsible way that is lacking".

FOOD WASTE

First of all, do not confuse the mess of the South and the mess of the North. In the South, we essentially lose at the harvest, due to a lack of adequate storage and transport equipment.

Waste is an inevitable by-product of societies creating and consuming goods. In 2016, more than 2 billion tons of waste were produced worldwide, with each person generating an average of 0.74 kilograms per day. More than half of the world's waste comes from food and plastic, with the other major categories being paper and cardboard, glass, metal, rubber, leather and wood.

The food supply chain is the route by which food moves from farms to our plates. Food is produced, stored, processed and distributed before being sold by retailers to consumers. Food losses correspond to products intended for human consumption that leave the food supply chain between their production and their arrival at the retailer. The most common causes of these losses are damage during harvest, losses during storage due to unsuitable temperatures, humidity or infestations. Food waste refers to foodstuffs that are thrown away by traders or consumers, for example because they have reached their use-by date or because they are damaged. The extent of food loss and waste at different stages of the supply chain differs by region. Waste is particularly high in North America, where ten times more food is lost at the consumption stage than in sub-Saharan Africa. In contrast, most food losses in low- and middle-income economies occur at the handling and storage stages, as many of these countries lack the infrastructure to properly store food.

Reducing food loss and waste is key to ending hunger. Nearly a third of the world's food production would thus end its life in the trash. The losses are estimated at 100 billion euros. So why a global scandal? Because, simultaneously, a billion people suffer from malnutrition in the world. Isn't it time to consume better?

When you don't have silos to store your grain (and a fortiori refrigerated milk tanks to store your milk), you are forced to share: part of the harvest for rats, part for diseases, part for the wind, part for the birds, part for the thieves, etc. and, of course, there is little left at the end since we have lost on average a third of what had cost us so much to produce. Note for example that until now Africa as a whole has always produced enough food to feed Africans. But, for lack of silos, trucks and roads, it has never been possible to feed the areas of shortage or famine with the surpluses produced in other regions...

Let's try to give some approximate figures to understand the extent of the problem.

A huge amount of trash divided into three equal parts

First, the basic number: we each put a ton of food in our mouths every year, including approximately 600 kilos of liquid and 400 kilos of solid. Let's stay on these 400 kilos of solid food (a little more than a kilo per day), and face the 240 kilos of food thrown away! This huge amount of waste is roughly divided into three equal parts.

The first third is discarded on the farm or in transport operations

I produce a twisted carrot, I throw it away since the consumer wants straight ones; I produce a melon that is too big or too small, I throw it away since we need calibrated melons, I produce an apple on which an insect has left a mark, I throw it away since we need perfect fruit! Let us note in passing that according to the maxim: "when you buy a product, you buy the world that goes with it", the con-

sumer who, at the supermarket, chooses one by one his apples, but also his plums and even his cherries, does not account that on the one hand it causes a real upstream purification of all the fruits which are not of perfect appearance, but also that of course it encourages the producer to multiply his doses of insecticides since the slightest insect which lands on the fruit risks signing its death warrant...

Another example is fish: when industrial trawlers cast their huge trawls to scrape the bottom of the sea, they bring up everything that is there, and therefore they have to throw away a good part of what they bring up: fish that are too small, too big, those whose fishing is prohibited, or which will not find takers on the market; and of course, unfortunately, most will not survive this shock treatment... Let us also mention transport, which gives rise to a multitude of fatal shocks for perishable products.

The second third is wasted at the industrialization and marketing stage

The agro-industrial factories work with impressive speeds, and, as soon as the slightest problem appears on the production lines, we are led to throw away the output produced between the start of the problem and the moment we notice it; so there are tons of sandwich loaves that are not perfectly square, twisted pizzas or rounded fish fingers that go to the dumpster! The same goes for marketing: let's imagine a supermarket that brings in a large quantity of skewers on the eve of a weekend in July when it starts to rain; on Mondays, he is obliged to throw away the skewers that have not ended up on the barbecue; since we are full, we have become obsessed with the use-by date, and, of course, everyone protects themselves for fear of lawsuits and we throw away an impressive quantity of dairy products or ready meals that have not found a buyer a few days before the use-by date, without forgetting the bread since no one buys bread from the day before, or the fillets of oranges or onions, one of the elements of which is rotten... In total, all this represents around 80 kilos per person per year.

The third tier is the one closest to the consumer

This third third corresponds to waste in restaurants since it is now out of the question to accommodate leftovers. Thus, in a totally unreasonable way, we throw away in hospitals, company restaurants, school canteens, etc. Let us remember, for example, that pork producers have not had the right for a long time to go out of the canteens of colleges and high schools to recover the remains of salsify or Brussels sprouts that our teenagers refuse to eat (so that this is still what happens in the very center of Beijing or Shanghai...). In addition, many restaurateurs have acquired large designer plates to look chic, and they are obliged to fill them so as not to be stingy; as, moreover, they obviously do not individualize the size of the portions (serving less to a grandmother than to her adolescent grandson!), logically many of them return full to the kitchen. This represents at least 40 kilos per person per year.

Of these 40 kilos thrown away per person per year, about ten are not very visible because they end up in the sewers or the composts which multiply, but there are still about thirty in the real municipal garbage cans.

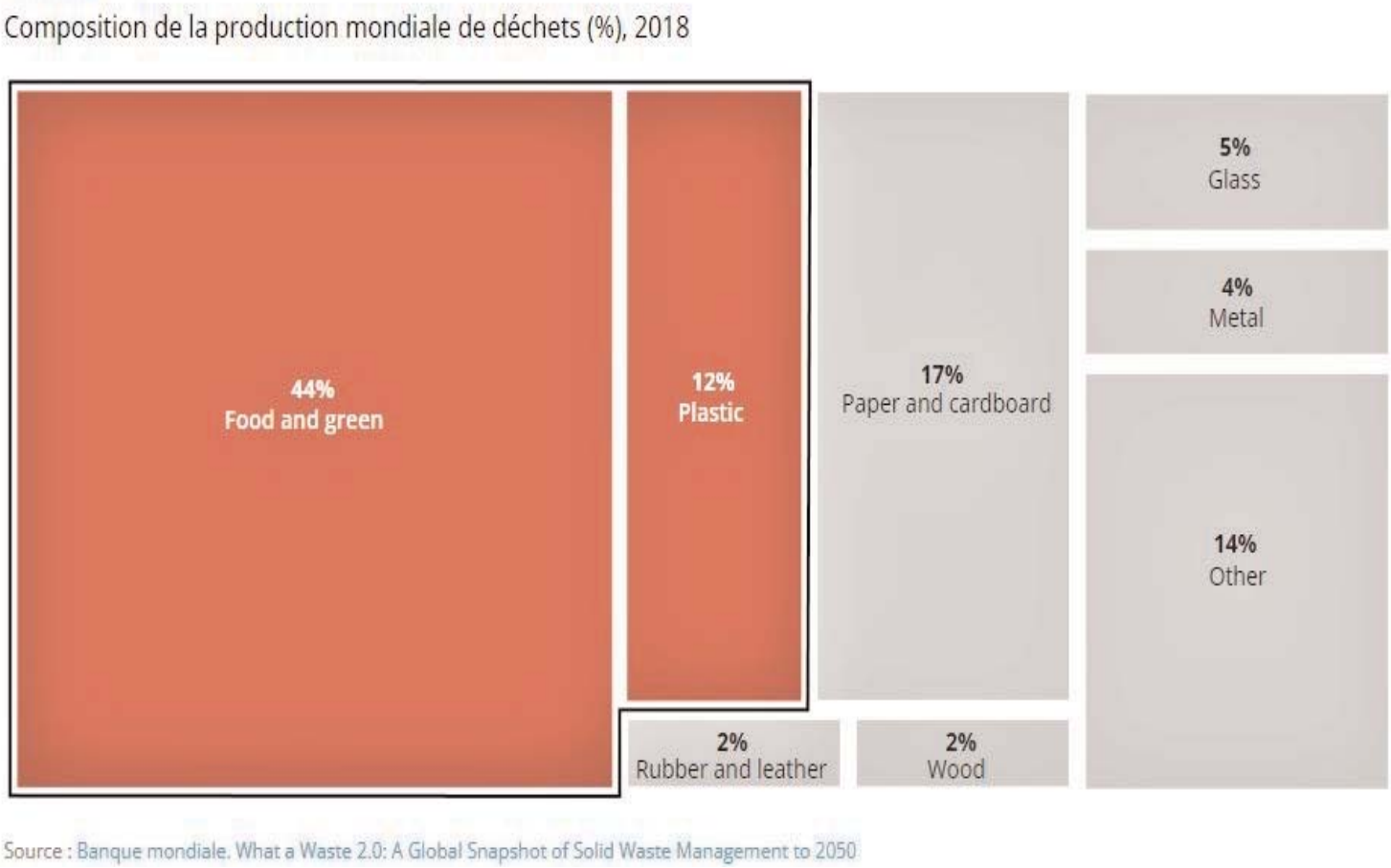
Aquaculture has shown galloping economic expansion over the past four decades. This form of farming concerns both fish and crustaceans, algae or molluscs such as mussels or oysters, and employs more than ten million people worldwide.

Have you always wondered what is aquaculture, if there are heavy metal issues? Or where is the use of GMO strains, the inventory of organic products, if aquaculture can feed humanity?

A consumer of widely distributed fish, crustaceans and shellfish, available all year round, often on promotion, will almost exclusively consume farmed aquatic products. Anyone who prefers large pieces, mentions "line" or "fished at sea", and of course species whose breeding is not yet developed, will consume almost exclusively wild products.

How to know ? The fishing or aquaculture origin depends entirely on the species purchased, the size chosen and the price per kilogram you are willing to pay. Thus, if you buy Atlantic salmon, it will be farmed, unless it bears a metallic "wild salmon" mark on the lid, which you will rarely find and at a high price: 90% of Atlantic salmon Atlantic salmon marketed today are farmed salmon. If you buy portion sea bass or sea bream, especially if their price is less than 18 euros per kilo and their origin is Greece or Turkey, it will be farmed fish. A bass exceeding 1 kg will most likely be wild. If it does not bear a metallic mark on the operculum, or if it bears a simple "Breton fish" mark, it will probably come from a lucky trawl from a boat going out for tides of one to two weeks. To be certain that it was line-fished by a small boat going out for the day, you will need to find a metallic "line bar" mark on its lid.
A bouchot or Spanish mussel will always be a farmed mussel. A shrimp from Ecuador or Colombia will be farmed. A shrimp from Guyana will be caught, like a shrimp "caught at sea" from Senegal or Madagascar. But an "organic" or red label shrimp from Madagascar or Ecuador will be farmed.

50% of the world's waste comes from food and plastic

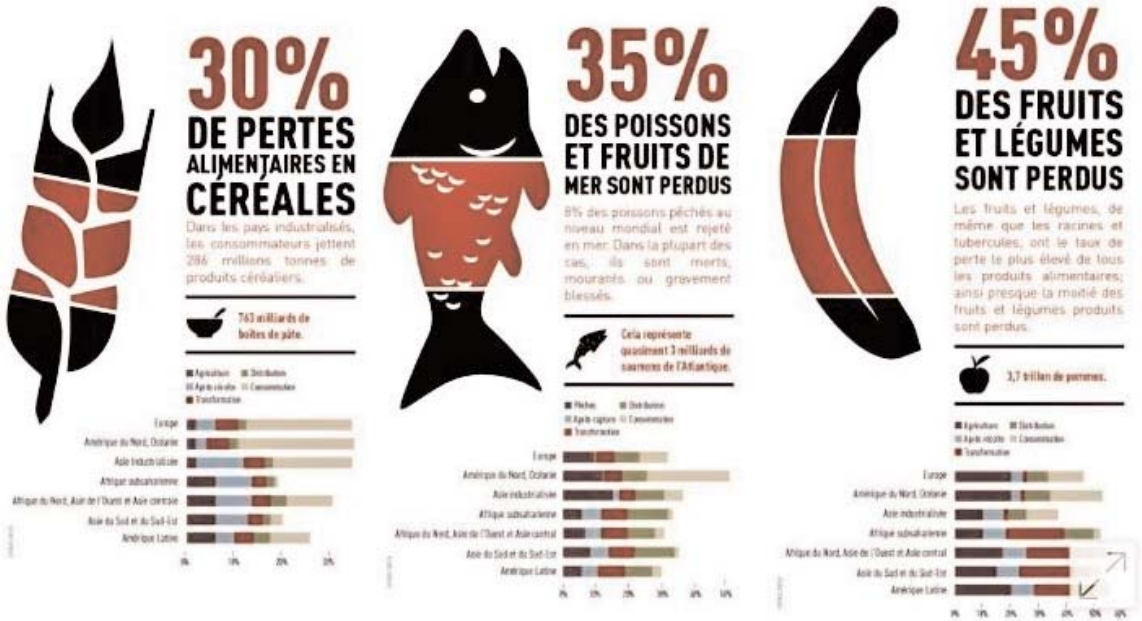


Wild fish circulate freely in the sea and in estuaries, occasionally entering areas polluted by urban, industrial or shipping waste. It feeds on what it finds, fish, molluscs or crustaceans, which may be perfectly healthy or be more or less strongly affected by a chemical or organic pollutant, or even infected by a transmissible pathogen or parasite. The farmed fish is confined in a basin supplied with water of controlled quality or in a cage established in a site without notable pollution. It is normally fed pieces of fish or a high-energy compound feed, both tested to ensure that they do not contain pollutants or pathogens.

But breeders who are more concerned with performance than quality can subject their fish to treatments that are harmful to the consumer (phytosanitary products in the water, antibiotics in the food) in the absence of sufficient time between the treatment and the marketing. The same producers can feed growth accelerators to their fish. A charter of best practices and rigorous monitoring of their implementation are essential to avoid these abuses.

A wild fish free of any pollutant or pathogen will therefore be healthier than a farmed fish, but a farmed fish free of any inadequate treatment or "doping" will be healthier than its wild counterpart affected by a pollutant or a pathogen. .

There should be no heavy metals in a fish. Such a presence is abnormal, and the professional who encounters such a situation has a duty to notify the authorities.



30% of cereal production, 35% of fruits and vegetables, 35% of fish are lost in consumption

Schematically, each individual in a food chain must consume about ten kilos of living matter to produce one kilo of its own flesh. Therefore, if what he eats contains n grams of a non-biodegradable component, which is the case of heavy metals, his flesh will take on 10n grams of this component. The predator that consumes it will have its flesh charged with 100n grams of the component, that of the third level predator with 1,000n grams, and so on at each subsequent level. However, care should be taken not to incorrectly deduce that the concentration of the component in the flesh of the predator will automatically be multiplied by 10 from one level to another. This would require the predator to consume prey all having the same load of the non-biodegradable component in question, therefore at the same level in the food chain and having been subjected to the same exposure. In practice, the multiplication factor is often closer in reality to 3 or 4 than to 10.

This level of 3 or 4 is however sufficient to find in end-of-chain predators, such as tuna or swordfish, levels of heavy metals, in particular in the form of methylmercury, comparable to those which caused the pollution. fish from Minamata Bay (Japan) in the 1950s. But it is not the annual consumption of five steaks of tuna or swordfish that will produce in a French consumer an intoxication comparable to that experienced by the populations of Minamata Bay fishermen, eating fish from the bay 365 days a year.

So the answer to the question posed is: yes, there can be heavy metals in some fish and any amount is too much! We will add that this does not prevent an occasional consumption of these fish, it being understood that we will avoid making it our exclusive food.

Is an aquaculture Minamata to be feared?

I searched the literature and asked colleagues. None of us found **a**ny trace of human poisoning by heavy metals present in the flesh of farmed fish. On the other hand, each time the question is asked, the Minamata disaster (Japan) comes up as a reference. More than 57 years after the official recognition of the facts, it is still, with 13,000 recognized victims, the fundamental reference in the field of human contamination by the consumption of fish loaded with mercury. But it contains two factors that cannot be transposed: on the one hand, a factory whose managers have been hiding for decades that it continuously discharges mercury-laden effluents into Minamata Bay, on the other, a population of small-scale fishermen whose sole source of animal protein is, year-round, fish caught in the bay. Hiding a release of this magnitude (400 tons of mercury in total) is fortunately no longer possible. To eat as a source of animal protein only aquaculture fish, from a single source, all year round, seems to me as monotonous as it is unimaginable.

But there are also meals from GMO plants in certain feeds for aquaculture, in particular GMO soybean meal. And if we extend the term GMO to the qualification of plants or animals resulting from hybridization or treatments that generate polyploidy, with the aim of producing sterile lines, with faster growth than the original animals, it There are GMO products in aquaculture today, especially oysters and salmon. The sterility of these lines nevertheless protects against the risk of multiplication of these individuals in the event of an escape. The only lesson to be learned from this is that diversifying your diet into nature and aquaculture sources is both a pleasure and a precaution.

At a time when in Europe food manufacturers are withdrawing a large quantity of frozen ready meals made from beef, in the United States, it is seafood products that are being singled out. Between 2010 and 2012, the NGO Oceana carried out a major investigation into the labeling fraud of food from the sea. In its report published on February 21, it shows that 33% of the fish sold are incorrectly labelled.

In this vast study led by researcher Kimberly Warner, 1,215 fish samples were analyzed. The NGO Oceana purchased them from 674 outlets in 21 states in the United States. DNA testing showed that a third of those samples failed to meet Food and Drug Administration (FDA) standards.

According to the study conducted by the NGO Océana, in sushi restaurants, 74% of fish sold to consumers were mislabeled. © Arnaud 25, cc by sa 3.0.

Snapper and albacore tuna that aren't
Tuna and snapper were the most commonly mislabeled fish. In 59% and 87% of cases, respectively, DNA tests revealed the presence of other species that were not listed on the packaging labels.

Additionally, only 7 of 120 samples from commercially purchased snappers were actually snapper. Additionally, 84% of the albacore tuna samples were actually representatives of Lepidocybium flavobrunneum, or black escolar, a species of fish that can cause serious digestive problems.

The main fish analyzed were salmon, snapper, cod, tuna, sole, halibut and grouper. Between 20 and more than 33% of halibut, groupers, bass and cod imported from Chile were mislabeled. Knowing that France imports 80% of seafood products, there is cause for concern.

Food losses during production are a global problem independent of region or income level: in many economies, a third of losses occur at this stage. In addition, as the COVID-19 pandemic has severely disrupted global supply chains, production losses are likely to worsen.

For example, due to the containment measures put in place in many countries to prevent the spread of the disease, restaurants have not always been able to use the food they have purchased, food that is at risk of be wasted if it is not redirected to food banks or grocery stores. However, the rising cost of food and uncertainties in supply chains may spark renewed momentum among consumers to curb food waste.

Reducing food loss and waste is key to ending hunger. More than 1.3 billion tons of food are wasted each year while almost 2 billion people are hungry or undernourished. To achieve the target, countries should focus on strategies targeting the stages of the supply chain where losses are greatest. For example, it is possible to produce more usable food with the same amount of resources or to provide farmers with better storage facilities, which could limit the amount of resources needed globally for food production.

At the very beginning of the 1970s, a report published by researchers at the Massachusetts Institute of Technology (MIT, USA) for the first time took stock of the impact of human activity on our Earth. The now infamous Meadows report warned: continuing on the path of ever greater consumption of our planet's resources would lead us into a wall. A wall erected somewhere on the way to our 21st century. A wall that would prevent us from having free access to natural resources. The result is a dramatic deterioration in our living conditions. Which could even lead to the demise of our civilization.

More than a wall, the Meadows report thus introduced, 50 years ago already, the concept of planetary limits. However, since then, our consumption of resources has continued to increase. So much so that before 2022, four of these planetary boundaries - more clearly defined by scientists from 2009 and more or less linked to each other - had already been crossed: that relating to the change in land use, that affecting the integrity of biodiversity, that of the disruption of phosphorus and nitrogen cycles and that of climate change. In January of this year, researchers from the Stockholm Resilience Center (SRC, Sweden) announced that a fifth limit had just been exceeded: that relating to chemical pollution.

A sixth planetary limit -- out of nine in total -- has just been crossed. The one that touches on the fresh water cycle. And this even though part of the world is experiencing a period of worrying drought and a quarter of the world's population does not have access to drinking water.

Plastics, pesticides, paints, antibiotics, drugs. Today there are something like 350,000 different types of manufactured chemicals on the market. And according to researchers from the Stockholm Resilience Center (Sweden), their production has multiplied by 50 since the beginning of the 1950s. It should even triple again by 2050.

The trouble is that significant volumes of these chemicals end up polluting nature every year. At a pace that researchers now say is incompatible with remaining "in a safe operating space for humanity." We would thus have crossed what researchers call a planetary boundary.

The circular economy solution

It is now done. And the researchers' results are not reassuring. There are indeed many ways in which manufactured chemicals in general and plastics in particular can have negative effects on our environment. Throughout the production chain, from mining to waste management. Some of these products have even been found as far away as Antarctica. And they can be extremely persistent.

In a Business as usual (BAU2) scenario, economic growth would reach its peak as early as 2040. Before experiencing a sharp slowdown with the effect of a net decrease in the world's population, food availability and natural resources. Marking, not the end of

humanity, but a turning point during which we can expect our standard of living to decline for decades.

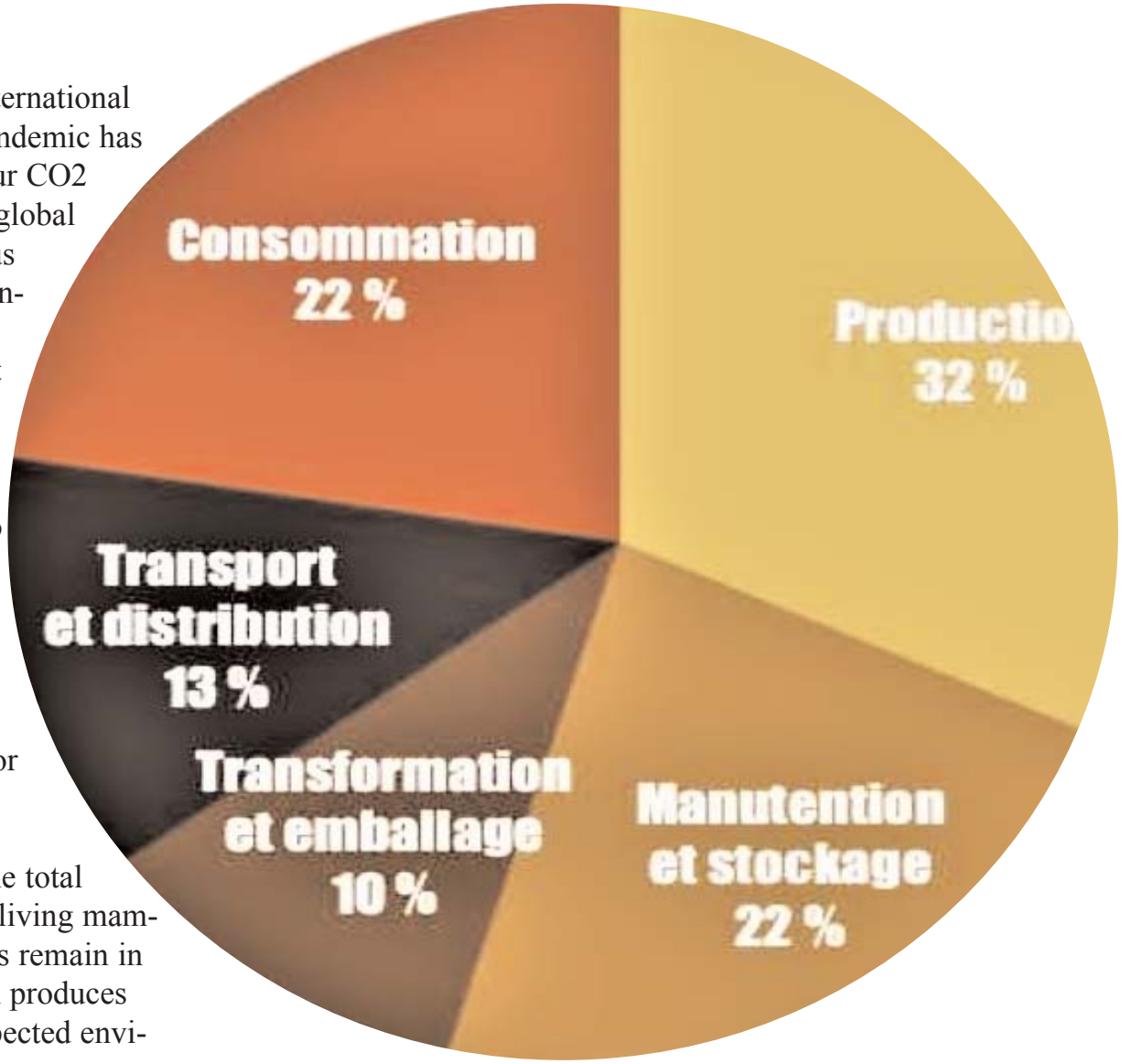
In the SW scenario, industrial growth and world population begin to stabilize shortly after this change in values. Food availability, meanwhile, continues to increase to meet the needs of the world's population. Pollution decreases until it practically disappears. The depletion of natural resources is also beginning to level off. The collapse of our civilization is avoided.

This scenario today seems a bit utopian even as the International Energy Agency (IEA) announces that the Covid-19 pandemic has marked a halt in clean energy investments. And that our CO2 emissions should reach a new record in 2023. But the global health crisis that we are experiencing has also shown us how humanity is capable of mobilizing quickly and constructively to face global challenges. According to the work of Gaya Herrington, we would have 10 years left to change the way we look at our societies and to save our civilization from collapse.

The researchers also note that these chemicals can also affect other planetary boundaries. When fossil fuels are used to produce them or microplastics pollute freshwater supplies, for example. And while scientists believe the rate at which these products are appearing now far exceeds the ability of governments to both assess risks and control potential problems, they call for "a cap on production and release of chemicals".

Among the most striking examples is that of plastic, the total mass of which on our planet is now twice that of... all living mammals! And we know that not only 80% of these plastics remain in the environment, but that in addition, their degradation produces new combinations which could represent as yet unsuspected environmental risks.

As a solution, the researchers evoke that of the circular economy. The idea, on the one hand, of designing products for recycling. So that they can be reused and not wasted. The idea, on the other hand, to better assess the safety and durability of these products, throughout their life in the Earth system.

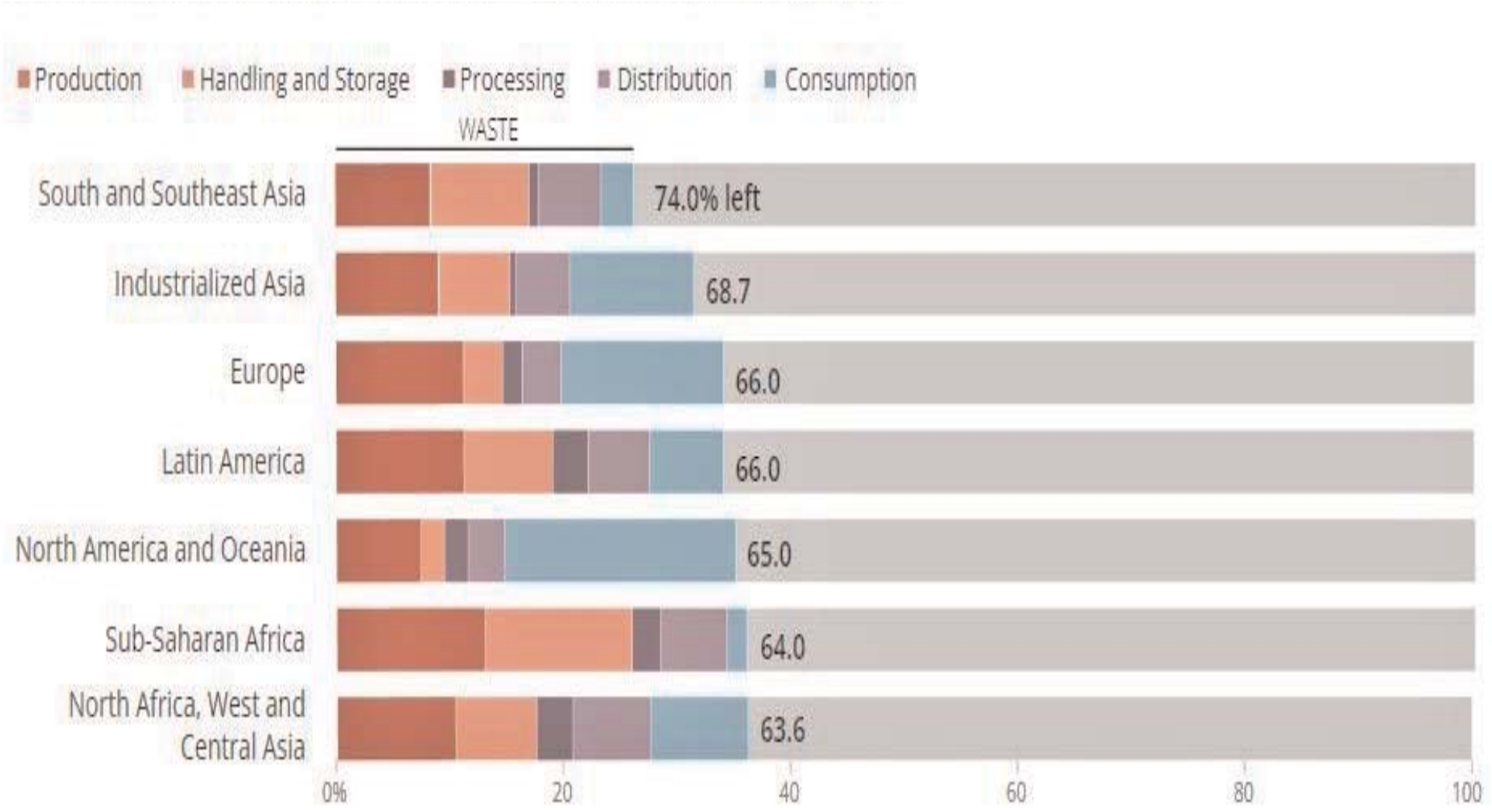


ALIMENTARY WASTE BY BRANCHS

An American or European domestic dog eats twice as much protein annually as a South American or African child.
1/3 OF OUR BIG GOES
LE TIERS DE CES PRODUITS DE CONSOMMATION SERA GASPILLE
Friskies
DOG FOOD
TOP CHOICE
Cobra
Process Art
Cocktail aux fruits
Structuralisme
Conceptuel
Plasticien
Evolutionnisme
Humanisme
Copy Art
Utopisme
JELL-O
Art Naïf
Funk Art
Cubisme
FRAISES
V8
Existentialisme
Fonctionnalisme
Relativisme
Renaissance
Futurisme
Hard Edge
Créationisme
Eclectisme
Néo-Géo
Dada
Art Brut
OREO
Baroque
Op Art
Mail Art
Informel
Figuratif
Fluxus
Body Art
Art Actuel
Fauvis

IN POOR COUNTRIES, MOST FOOD LOSSES ARE RELATED TO PRODUCTION AND DISTRIBUTION, WHILE IN RICH COUNTRIES, THEY ARE RELATED TO CONSUMPTION

Food losses at each stage of the supply chain (%)



Source : World Resources Institute. Reducing Food Loss and Waste: Setting a Global Action Agenda

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FLOWMASTER
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TEXACO
WAL★MART
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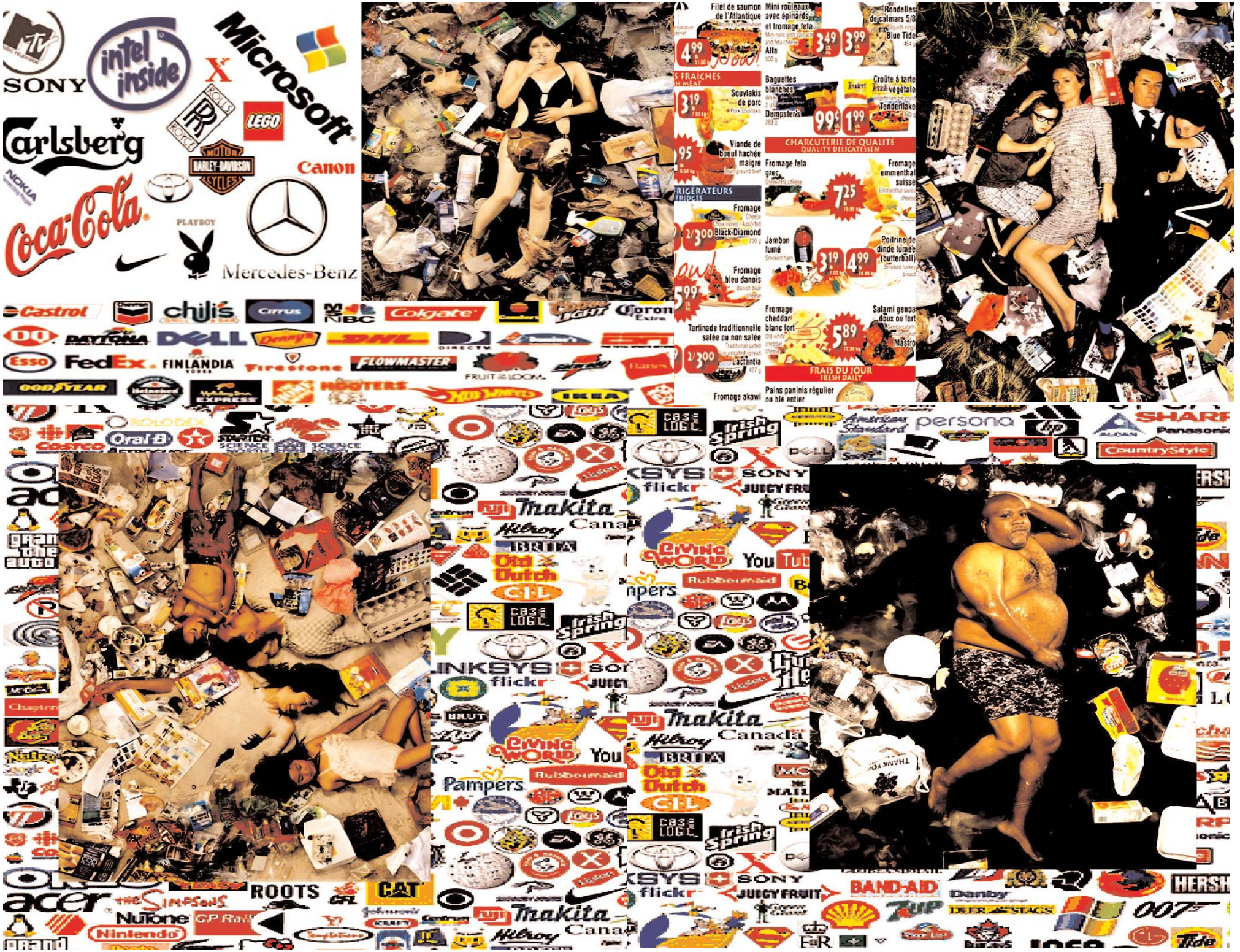
zippo
Zantac


SONY
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FedEx
FINLANDIA
Firestone
FLOWMASTER
GOODYEAR
HOOTERS
IKEA
Filet de saumon de l'Atlantique
Mini rouleaux avec épinards et fromage feta
Rondelles de calmars 5/8
Blue Tide
Alfa
Baguettes blanches
Croûte à tarte
Tenderflake
Dempsters
Souvlakis de porc
Viande de boeuf hachée maigre
CHARCUTERIE DE QUALITE
QUALITY DELICATESSEN
Fromage feta grec
Fromage emmenthal suisse
Jambon fumé
Poitrine de dinde fumée (butterball)
Fromage cheddar blanc fort
Salami genoa doux ou fort
Mastro
FRAIS DU JOUR
FRESH DAILY
Pains paninis régulier ou blé entier
Fromage akawi
Tartinade traditionnelle salée ou non salée
Lactantia
Fromage bleu danois
Black-Diamond
Fromage
Viande
Souvlakis
Baguettes
Dempsters
Alfa
Filet
Mini
Rondelles
Blue Tide
Croûte
Tenderflake
Jambon
Poitrine
Salami
Mastro
Pains
Tartinade
Lactantia
Fromage
Black-Diamond
Oral-B
Costco
Makita
Old Dutch
Case Logic
Irish Spring
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Rubbermaid
Pampers
Canada
Persona
SHARP
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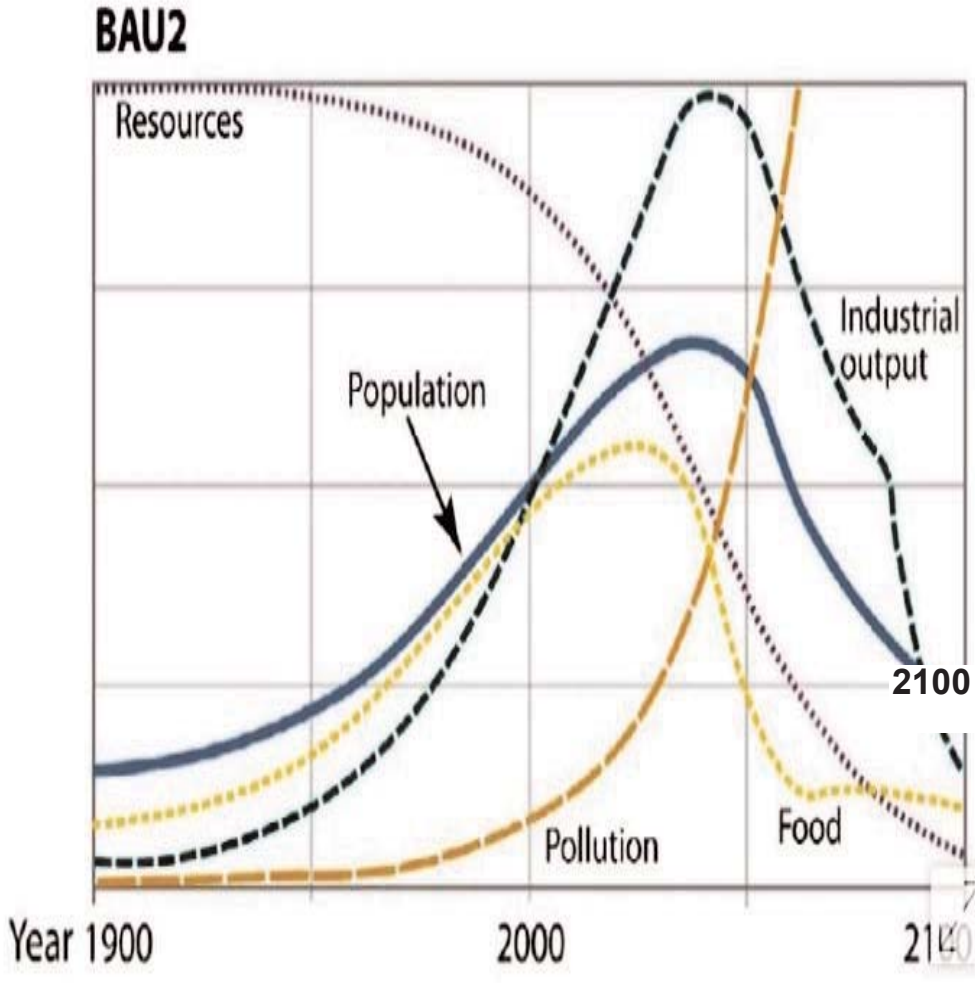
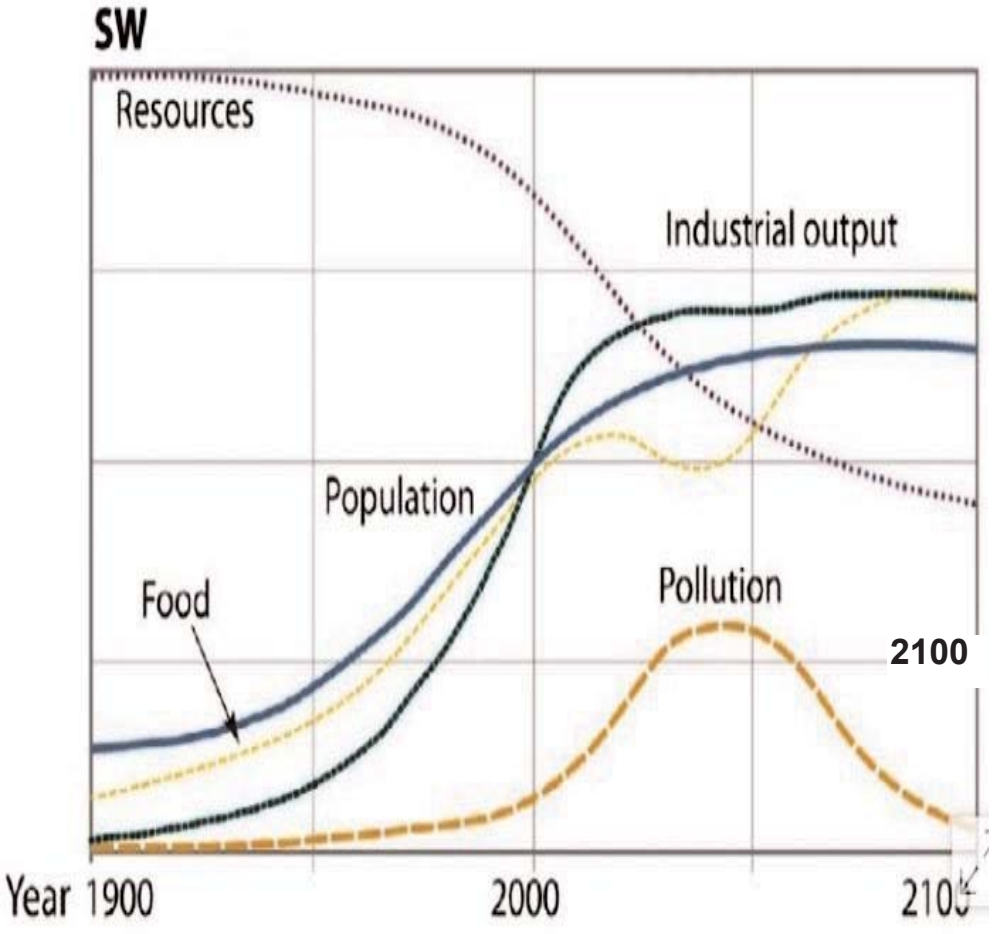


e scénario *Business as usual* (BAU2) conduit à un effondrement de notre civilisation qui début aux alentours de 2040. © Herrington, 2021

The Business as usual (BAU2) scenario leads to a collapse of our civilization that begins around 2040. © Herrington,2021



Dans le scénario *Stabilized world* (SW), nos priorités changent aux alentours de 2020 et en limit volontairement notre croissance économique, nous parvenons à créer une société durable. © Herrington, 2021

In the Stabilized world (SW) scenario, our priorities change around 2020 and by voluntarily limiting our economic growth, we manage to create a sustainable society. © Herrington, 2021

DIESE ANZÜGE SIND
ein DIAGRAM
MATHIAS
DIE ABBILDUNGS-HÄUFIGKEIT
Realkings

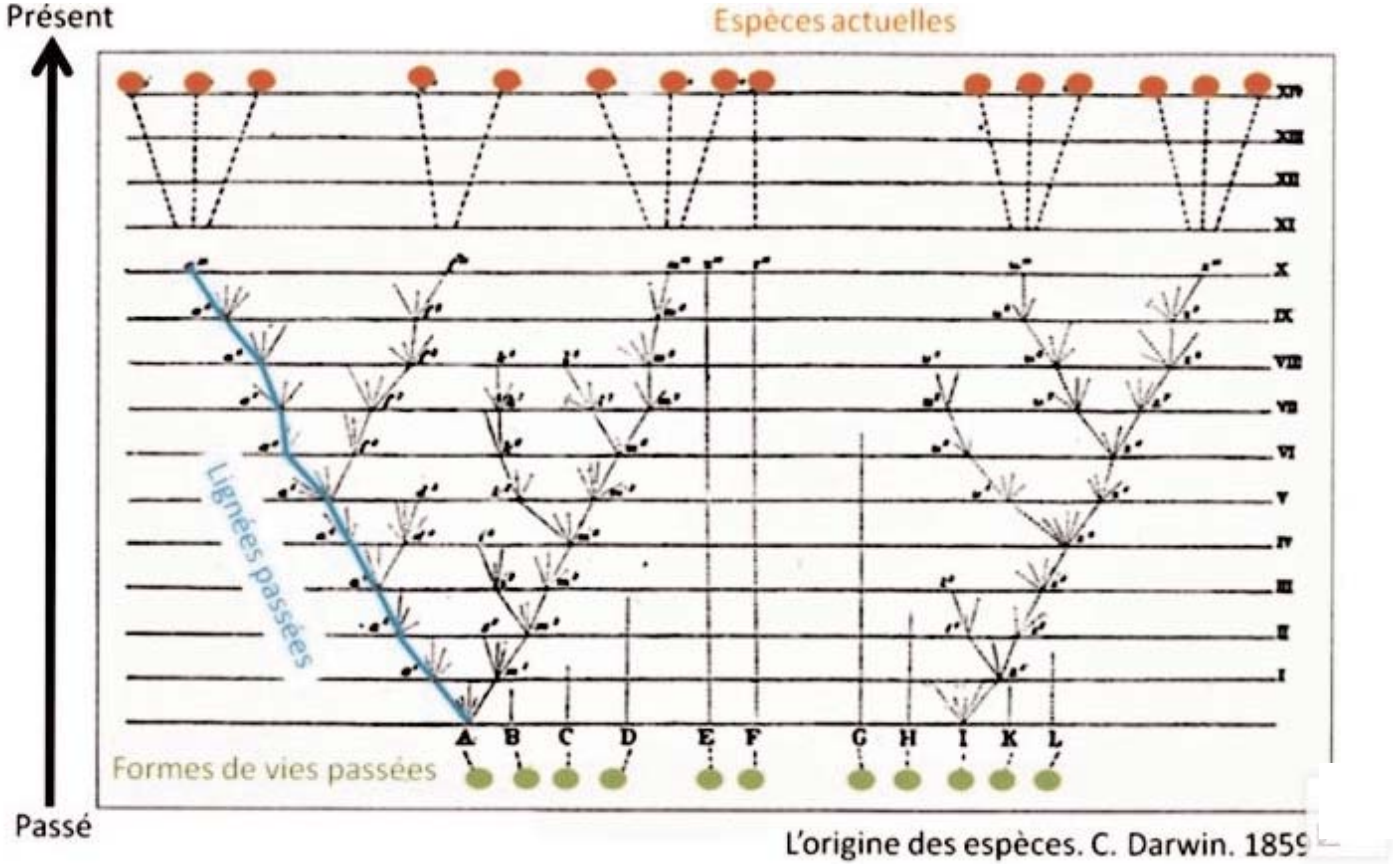
Between Anthropocene and Thanatocene… there is the Capitalocene.

The genes of the warrior

Is the war instinct inscribed in our genes? or an emanation of culture?

The evolution of the majority of biological beings -- viruses, bacteria, archaea and eukaryotes -- is more complicated to understand than previously anticipated. It presupposes taking into account functional and genetic interactions between forms that evolve very differently, in addition to studying the genealogy of these beings. Typically, to understand who we are, we must also understand who we live with. To know man better, it is not enough to study the genes of human DNA, it is also necessary to study the genes and the journeys of the DNA of our genetic partners. Our theories must also describe the emergence of evolutionary novelties and new biological systems resulting from alliances, fueled by the journeys of genes. In the near future, therefore, the pluralistic evolutionist may have to study much more than a tree. Many network models are already increasingly used by scientists to describe genetic partnerships and DNA movements within lineages and between lineages. It is an evolution of the theory of evolution, what is expected of an active science, quite the opposite of an immutable dogma.

Nearly six hundred million years later, an event of a completely different nature is happening in the African savannahs. It is no longer a matter of a proliferation of organisms built on different plans from each other, but of a lineage which acquires in a short time (always on the scale of evolution of course) new ones that will once again revolutionize the planet. It is about the emergence of hominids. Is it really a single lineage? Probably not. Many anthropologists believe that the genus Homo itself comprised perhaps as many as 10 or 20 distinct species, of which only one remains today, a set of species that gives the image of a bush more than that of a single lineage.



Darwin's Tree. This unique figure of the origin of species illustrates the process of descent with modifications. This process establishes genealogical links between living beings. Ancestral species and life forms are located at the base of this drawing. Under the action of natural selection, members of a species diverge over generations, giving rise to new lineages. For this reason, the contemporary species (at the top of the drawing) are connected to their ancestors by a long series of now extinct intermediate lineages. All the lines take the form of a tree.

Why is the appearance of this original primate, erect on its hind limbs and endowed with a large brain, a revolution? Nothing in the general morphology of our species is really original. None of our molecules, none of our cells, none of our organs are built on new plans compared to our primate ancestors and even compared to mammals in general. It is on a finer scale, in the coordinated association of four distinct structures, that the novelty lies.

These four structures are:

* a mobile hand freed from the constraints of walking thanks to bipedalism
* a larynx whose muscles and nerves allow the emission of various sounds
* a brain whose complexity exceeds anything that evolution had produced so far: 10,000 billion neurons, each of which establishes up to 1,000 synapses with other neurons. A brain that can command the hand and the larynx.
* the invention of the tool first for domestic use and later becoming a weapon.

The question of the "human revolution" presents itself in a noticeably different form if we reason in terms of information.
The discoveries of molecular biology have shown that all living beings are built on the basis of information which is expressed in the genetic code and which is materially carried by the nucleic acid molecules of the chromosomes. The language in which this information is expressed is remarkably simple: four letters and 3-letter words, which gives 80 possible words of which only 20 are used. These 20 words, assembled in the genes in the form of "sentences", are enough to convey the information from which all living beings are built, including all humans. The most recent estimates based on the ongoing study of the human genome suggest that it is made up of about 45,000 genes (a gene is a "sentence" comprising between 1,000 and 100,000 "letters").

The genetic code is, except for minute details, the same for all living beings today, which suggests that all these beings derive from a common stock (this means, concretely, that all organisms, animals like plants, are our cousins).

And this common strain: memory points

It will be up to the mathematician and physicist Louis de Broglie to formulate that each particle has a "look" outward called "psi wave" coupled to an interior memory called "sigma field" which allows a choice of behaviors according to the set of symbols that 'she disposes; this choice is therefore based on "memory points". Each particle has a cumulative memory and its behavior increases by crossing thresholds, stages. What you have to understand is that all the particles in the Universe have a set of symbols at their disposal, some particles will be high resolution others low, a bit like the number of resolution points on a screen of high definition TV versus a standard screen. Here is now the most fundamental theorem of modern mathematics: Zermelo's theorem directly related to memory points.

EVERYTHING CAN BE WELL ORDERED

It is the variations that arise through mutation in the genetic information that are the necessary condition for "evolution". It is enough that living beings carrying different information do not have the same reproductive success for certain genes or certain combinations of genes to spread (or on the contrary to disappear) in populations. It is the process of natural selection, proposed by Charles Darwin and which still forms the basis of the modern theory of evolution. However, when a favorable mutation appears in the germline of an individual, its transmission to the next generation is not guaranteed, if only because natural selection is subject to many hazards. As for favorable gene combinations, their transmission is even more uncertain because of genetic recombination which, during meiosis, can disperse these genes in different gametes. It is understandable that such a system for transmitting information was remarkably slow.

It is believed that the history of life took at least 3.5 billion years. Scholarly Broglian calculations (fusion of particles with spin) enabled physicists to take a fresh look at matter. Thus the mineral world would have a set of 256 memory positions, the plant, next level, with its 65.536 positions, the animal with its 4 billion memory positions, the human being with its 18 billion billion memory positions and the next stage will give rise to an entity possessing 340 billion, billions of billions of billions of memory positions. (Charon, The Whole, matter, spirit, 1987)

If we place ourselves at the level of elementary particles and at the atomic level, we realize that stone, flower and whitecoat are identical. It is only at the level of the molecules that significant differences appear at the level of the differences in matter between the mineral world and the organic world. Thus the whitecoat appears much more structured than the flower and the flower more than the stone. The fundamental difference between the "inert" and the living is quite simply that one is richer in information than the other and inside the living world, the species themselves all have almost an informational baggage identical to a few discomforts.

At the very beginning of evolution (say over 2 billion years ago), life had acquired the cellular structure. The cell is an entity by its structure and its functioning, and its most essential characteristic is immortality. Indeed, any cell has the potential to divide to give birth to two daughter cells, which will do the same and so on indefinitely. The death of a single-celled organism can only occur by accident. The genetic information that a cell possesses is thus transmitted indefinitely to its offspring, possibly with the mutations that occur when the DNA replicates before being distributed between the two daughter cells.

A little later, however, perhaps 1.5 billion years ago, multicellular organisms appeared. These originate from a new (and revolutionary!) fact: instead of separating after division, the cells coming from an initial mother cell remain attached to each other.

It is then that evolution invents, so to speak, cell death. More exactly, the multicellular organism is hierarchized in two territories: one contains the sexual cells, always potentially immortal they constitute the "germ"; the other contains all the other cells and these are programmed in their genome to last only one time they constitute the "soma". Only the germ now transmits genetic information (which it has received from the previous generation and to which mutations can always be added). The soma (connective, muscle, nerve cells, etc.) ages and dies without transmitting either the information received from the previous generation or any information it has received during life.

Of course, the individual continues to die (living beings must be programmed to die; this death is the sine qua non of biological evolution whose rule is the renewal of diversity in a finite space). But what the individual has acquired during his life does not die, or at least does not die entirely.

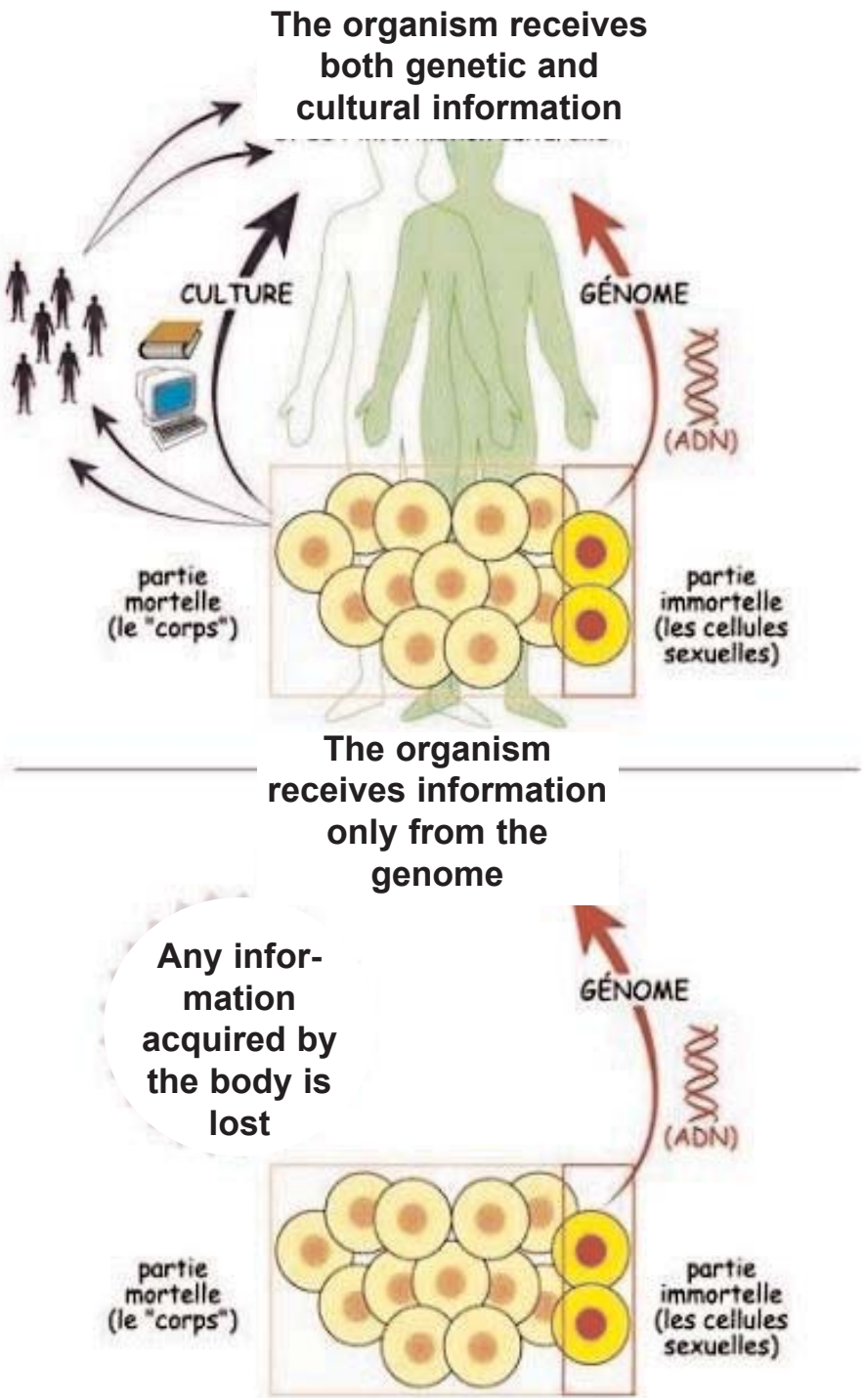
Better still, language and all the processes that derive from it (storage and deferred restitution) make it possible to transmit information, not only to descendants but also to an indeterminate (and sometimes immense) number of individuals.

Life is therefore matter better informed than inert characterized by its evolution and there is indeed a continuous passage from inorganic matter to life as observed on stromatolites, these stones which are called "bioconstructors ". These are rocks enveloped in a thin layer of microscopic bacteria that make up the living part of the rock. Stromatolites are therefore organo-sedimentary structures depository of the first manifestations of life on earth. We will then speak of "self-organized criticality": from a critical development threshold, a system tends to spontaneously reach a higher level of organization or performance in a more complex mode. We are talking here about emergent properties. This evolution can be done either without transition, or go through a "chaotic" phase, like a kind of indecision. These finally become observable when they go in the direction of a

new organization.

Richard Buckminster Fuller proposed to name "synergy" the combination of several functions ensuring the emergence of a single distinct function. Synergy (from the Greek synergos meaning "to work together") refers to the phenomenon in which several factors or influences acting together create an effect greater than the sum of the effects expected if they had operated independently. The Chilean researchers Maturana and Varela transposed the synergetic phenomenon to biology, which they called "autopoiesis" (Greek auto (oneself), and poièsis (production, creation). It defines the property of a system to to produce itself and to maintain itself, to define itself. Henri Atlan, in an Interview in the newspaper Le Monde dated November 19, 1991, declares that the idea of self-organization "corresponds very broadly to the hypothesis of a program that would program itself.

An example of an autopoietic system is the biological cell. The cell is made up of various biochemical components, like nucleic acids and proteins, and is organized into limited structures like the cell nucleus, various organelles, a cell membrane,



While a single-celled organism is immortal, a multi-celled organism is hierarchized into an immortal region and a mortal region.

and the cytoskeleton. These structures based on an external flow of molecules and energy "produce" the components which, in turn, continue to maintain the contained structure, allowing the growth of these components. The first forms of life, probably bacteria, appeared nearly 3.5 billion years ago. 600 million years ago flat-bodied organisms, algae and plant mosses appear, followed by scorpions, spiders and crustaceans. Around 360 million years ago, the eusthenopteron foordi, the famous fossil fish discovered at Miguasha in Gaspésie (Quebec - Canada) with terrestrial respiration and being able to crawl, undertook the difficult and perilous exit from the water and found itself in an environment totally different where ferns, among others, reach more than 30 meters in height. Continental drift has only just begun. All the continents are united in a compact mass under the Equator. Even more incredible, in addition to breathing, our first ancestor moves by relying on articulated bones (our current limbs, legs and forearms).

Yes, man is a descendant of fish and evolution for several other million years became more complex: amphibians, dinosaurs, birds, primates (50 million years) and finally the arboreal Australopithecus (5 million years) our primate ancestor followed by Homo erectus (one million years) and Neanderthals (300,000 years) and finally Homo sapiens, our 40,000 year old immediate ancestor. According to André Bourguignon in The Unexpected Man: "the self-organization of matter into diverse and ever more complex forms has taken place through random oscillations, trial and error, trial and error, around an axis oriented in time. , whose two extremities are represented by a single entity: originally the simplest chemical species, the hydrogen atom; at the present time the most complex animal structure, Man". (in Natural History of Man, The Unforeseen Man, Volume 1, PUF, Paris. 1989, p.299)

Thus emerges an unavoidable constant, the purpose of life is to increase the Consciousness of the living and each cell continuously exchanges information with its environment to increase its "memory points". The construction of the human brain whose 1013 neurons once deployed in the cerebral connective are connected by 1015 synapses constitutes a performance that defies all imagination. Following the Broglian theorem, it goes without saying that henceforth, creation and evolution go hand in hand. At the current state of our knowledge, the big bang appears as a rupture, a sudden creation characterized by the evolution of information in matter until the appearance of life. Then this stock of information did not stop growing and for millions of years, our brain was constituted thanks to the exponential volume of cultural and technical information acquired by practice and transmitted by tradition.

With man, a new method of transmitting information appears. As the English biologist Kevin Laland notes, as soon as a human figured out how to make a flint into a tool, he had the ability to pass on the information ("this is how I made the tool") not by the language of genes but by the language of his larynx. While a character acquired during life and concerning the body is not transmitted by genes, know-how can be transmitted from individual to individual as soon as this new information vehicle exists. what is a spoken language. It is this transmission of acquired characteristics which constitutes the human revolution. It is she who gave birth to culture.

Better still, a particular individual receives information, not just from paternal and maternal chromosomes, but from an almost infinite number of unrelated informants: his congeners.

It will therefore be necessary to wait for the most recent period of evolution for the soma to die, but for the information it has been able to acquire not necessarily to be lost. If we come back to the image of a prehistoric man discovering how to carve a handaxe, it is not through his germplasm that he will pass on his know-how to his children, but through his language (later, this will be the books, the universities, the media, the web) product of his brain, his muscles, his nerves, his larynx.

- Three and a half billion years between the first gene and the first university....
- Two billion years, or close to it, for language to triumph over cell death.
- But what a victory!

"When men know all the effectiveness of this instrument (reason), what hell will they not create around them.". (Georg Forster).

In the beginning was wandering; wandering of the primordial Australopithecus from 7 to 2 million years ago. For millennia, Australopithecus was essentially a vegetarian and would experience a wandering of gathering, moving from place to place in search of necessary food. This activity was essentially individualistic, each being responsible for his survival. We can speak here of a relative peaceful coexistence between hominid groups in a totally cruel world.

The aggressiveness was essentially defensive in nature. (Chatwin) It's about imagining our arboreal ancestor living in an environment of carnivorous predators, to understand that he is regularly attacked and that all his vegetarian aggression is directed towards defense for his survival. We also think of the defensive aggressiveness of the mother protecting her offspring. It is the era of matriarchy centered around the female, because not only does she give life but above all, she protects it, she is the guarantee of the evolution of the species. This matriarchal era will last almost 5 million years, a duration several times greater than that of the patriarchy which dates from around 2 million years ago until today. The matriarchal diet was essentially based on vegetarianism (gathering) while that of the patriarchy was mainly based on meat (hunting). The female will always be associated with the plant world, with nourishing earth, with agriculture, with the fertility of life.

Periods of overpopulation in groups of vegetarian Australopithecines set in motion mechanisms of regularization, the main one being the social exclusion of fasting males, by the alpha male, classified as supernumerary and forced to live at the limits of the territory claimed by the group. These "superfluous" do not have access to the food resources of the group, nor access to females for mating. Non-reproductive, the superfluous, often solitary, deprived of the protection of the group, suffer cruelly from the threats of the outside world and are more exposed to falling prey to ferocious carnivorous predators. Also excluded from nourishing territories where resources abound, they often face scarcity so that they must regularly travel long distances to satisfy their needs.

"The path is made by walking"

Since they can no longer count on the group to help and support them, they are condemned to form a new community with the other excluded groups capable of meeting their needs. Because they are young, these superfluous are more apt to experiment with new behaviors and often have the leisure to observe the behavior of predators in order to better protect themselves against them.

Overall, they discover not only new behaviors but also new foods. In times of famine, they do not hesitate to taste the carcasses of animals abandoned by predators. At first accidental, these behaviors gradually become habitual: looting the birds' nests to steal the eggs or devour the chicks, eating the placenta and naturally aborted fetuses, consuming nascent animal fasts. Thus is set up a replacement diet that will quickly become complementary to the initial vegetarianism.

When major climatic changes such as glaciations loom on the horizon, disturbances occur with them that upset the entire ecosystem of flora and fauna: strict predators die from the scarcity of animals, strict vegetarians die from the scarcity of plants and fruits, only the superfluous, both carnivores and vegetarians, have been able to adapt to the new environmental conditions. The excluded have become the dominators of a new existential paradigm, they form communities "of the future" and adopt behaviors such as direct action of group predation, the ancestor of hunting. Thus, everything happened as if the mechanisms of exclusion had "programmed" the transforming mechanisms which allowed the birth of hominids. In short, the marginalized have saved our species from natural extinction by offering it a better ecological balance which has increased our autonomy vis-à-vis the surrounding natural environment. (Moscovici, 1994)

Of the different families of Australopithecus, only the line of Australopithecus africanus and its descendants such as Homo habilis, Homo erectus, Neanderthal Man and finally Homo sapiens also called Cro-Magnon integrate meat into their menu; becoming omnivorous. The integration of meat into their diet is of paramount importance in the history of evolution and marks the beginnings of hunting after a long period of carrion including cannibalism. Indeed, only the lineage of the omnivorous Australopithecus (Homo habilis) will survive; strict vegetarians will disappear, unable to compensate

for the harmful effects of the periods of glaciation on the plants which nourished them; weakened, they become easy prey for carnivores. Homo habilis also owes its survival to a major anatomical change: the lengthening of the legs which allows it to eventually reach the upright position, thus freeing the hands for other occupations. Its only code of "conduct" is nature, it is the language of nature where everything is played out at the level of instincts and innate behaviors. From vegetarian to omnivorous therefore also carnivorous, he adapts his behavior to his new diet and adopts hunting as another means of subsistence. With hunting, the Australopithecus' brain doubles in size, not overnight, but spread over a few hundred thousand, even millions of years. (At that time, we took the time necessary to do things well).

Patiently, the Australopithecus, disadvantaged by nature, will create, from bones (knives, club) and branches (assegai), the weapons necessary for its survival. Without weapons, it's a safe bet that we wouldn't exist. Because the hordes of prehistory live in a world of terror and merciless cruelty where death was unthought, it happened suddenly, "kill to live" period. Australopithecus was scared, yes! by instinct but the fear of dying did not exist.

For the first time, an activity (hunting) required the association of members of the group with a view to a precise objective and cooperation in sharing the game killed. Thus will be born the notion of group, tribe or if you prefer the sociability necessary for attack (hunting) but also for defense against other predators. The arrival of meat in the diet introduces into behavior the offensive aggressiveness necessary for attacking game (predation) which complements the defensive aggressiveness of arboreal vegetarians. From now on, the development of aggressiveness in Australopithecus will follow the rules of hunting. We are thus witnessing for the first time a division of tasks: the defensive maternal aggressiveness will serve mainly to protect the camp and the newborns and to pick berries, nuts, tubers and fruits while the predatory male will hunt; although the female may sometimes participate in the predation effort by hunting small game around the base camp. (Here there is no sexism, the aggressiveness of the female being identical to that of the male in intensity at least)

The anthropologist-economist Marshall Sahlins (1972) estimates that "the hunter-gatherer could amass what was required to live (food, shelter, medicinal plants, tools) after fifteen hours of effort per week; thus the rest of his time he used it freely for play and rest. Such was the original affluent society." Our ancestor therefore had time to play but also to concentrate and reflect on his condition and above all to experiment. (Rasmussen, 2004)

"With Australopithecus (Homo Habilis), between 3 million and 1 million years ago, the first tools appeared, traces of a technical behavior, external to the anatomy. The reproduction of the same gestures organized in logical and effective sequences proves the existence of the first concepts. The handling and use of these tools formed a motor for the sequence of ideas. There are remains of hunting and gathering showing the observation and prediction of animal behavior. In particular shelters developed indicate the existence of a meeting place, a protected place where young people could be educated and women fed by hunters. This implies the existence of a prolonged learning process compared to other primates, therefore an educational mode allowing the transmission of an acquired social behavior.The elements at the origins of the first metaphysical experiences were therefore present: the emergence of consciousness leading to creativity on (revelation) of its equivalent in the sacred (unconscious) domain inaccessible by reason". (Bernard G. Campbell ed., Humankind emerging, 4th ed., Boston-Toronto, 1983, p. 228)

The archaic hunter, like a tadpole becomes a frog, acquires, assimilates, discovers the demands of his new condition as a warrior; the techniques of manufacturing new objects will cause humanity to make a prodigious leap. This Upper Paleolithic period is the most brilliant, rich and complex evolutionary period of prehistory seen

from the angle of human development of consciousness and society. A real boost. Frames, handles, levers come to furnish the hardware of household tools. Decorative objects other than "religious" appear. The space is structured, base camp, seasonal camp, the habitat is better organized, delimited by walls. Hunting specializes: big game hunters (mammoths, rhinos), herd animal hunters (horses, reindeer); each specialty having its own techniques, appropriate weapons and rituals.

So much so that the tool is inseparable from the sacred. Not only does it ensure the survival and development of the species, but it produces a whole universe of mythico-religious relations, if only the mastery of distance by the throwing of the assegai, which nourishes the creative imagination than the body. A general "philosophy" of life, a new culture appears where spiritual, political and warrior powers are in the hands of men in search of power.

One of the most influential informants was the shaman. The role of the rishis, the Indian shamans was to split the plenitude of the original vibration into syllables and phonemes then to combine them to form words, sentences: the language, to end up finally in the sacred texts thanks to writing. These masters of the Word seized on magical practices, myths and beliefs from the dawn of time and proceeded to put them into poetic form: the tale, poetry, discourse of the origins of oral traditions were then transcribed into the Vedic corpus; Veda literally meaning "Knowledge". (Hulin Michel, The seers of the Veda in The Book of Wisdom, Bayard Editions, Paris 2002, p. 40)

The Universe as a thought/word, a poietics which materialized by arranging with materials in order to form a visual poem of shapes, colors, sensations; the Universe as a poem that creates its own verbi-voco-visual language according to the archaic Tradition of the first peoples. To the material beauty of the forms is juxtaposed that no less mysterious and immaterial of the Breath, of the Word, as expressed by the throat songs of the Inuit and other mantras or universal shamanist chants at the origin of "In the beginning was the Word". .

This supposes that our universe is a paradoxical world, a thought conscripted into matter and we will see that our universe is just that, paradoxical, thanks to the quantum equations on the "memory points" of matter set out by de Broglie, price Nobel Prize in Physics.

In ancient Greece, poetry constitutes one of the typical forms of the shamanist experience inherited from the archaic cults of prehistory where the divine Word is transmitted to the medium.

The bard, the poet is the shaman of ancient Greece; and it is in this capacity that Homer and Hesiod were recognized as the founders of culture. Thus the poet becomes a being of memory capable of linking the past, the present and the future in an allegorical narrative thanks to which the whole of society understands its origin and discerns the tensions and balances which constitute its structure. Thus Homer, in the Iliad, affirms that the ocean is the father of everything. Hesiod's Theogony (8th century) is already more complex because it makes a first synthesis of older traditions. Hesiod uses his poetic intuition and his inner experience to "invent" the Origin of the World from the Void.

For ancient Greece, the cosmos is a term whose first meaning means "order" but also beauty and harmony. At first, Thales of Miletus, born around 625 BC. JC, believes that the earth is carried by the water which surrounds the planet below and above the celestial vault like the fetus bathing in the placenta in the uterus. This Universe is of modest size and closed, hence the concept of "cradle of humanity". Subsequently, with Anaximander the cosmos bathes in the apeiron i .e. the Infinite. the Indefinite and the Indeterminate. The cosmos is a balance between equal and opposite forces (water, fire, air and earth) like the Chinese T'ai Chi and the Indian Veda. The multiplicity of things is ordered in a set called the Cosmos and

this set is governed by laws. It is in this historical constant that lies the undeniable influence of the philosophy of Pythagoras.

It will be up to Pythagoras (6th century BC) to be the first to establish an unprecedented link between the traditional vision and the nascent ancient science. Pythagoras made a trip to Egypt where he learned from priests and scholars. According to Porphyry, he learned the mathematical sciences from the Phoenicians, geometry from the Egyptians, the study of the sky from the Chaldeans, and the precepts on the conduct of daily life he received from the Persian Magi. Heraclitus will say of him "that he is of all men the one who has drawn the most from historical sources; he has made a choice in all the works and has composed his own wisdom from them".

Pythagoras firmly believes in the existence of a natural order and what interests him in the first place is not to discover its material substance but its structure. Pythagoras, "father" of mathematics, strongly inspired by the Babylonians, introduced the mystique of number as the principle and source of all things. "Everything is number" and "Everything is harmony of opposites", everything that is alive is related to it, hence the study of astronomy.

The works of Pythagoras come to the conclusion that mathematical laws govern the order of things based on harmony, more precisely musical harmony: "the music of the spheres". Music and the natural order of the Universe are interconnected by mathematical links. With the musical harmony and the mathematical concepts inherent in the constitution of the world, Pythagoras leads us with him towards abstraction as knowledge of the Universe; matter becomes subordinate to the idea, to the thought which structures it. And thought forms speech and governs it by the participation and mixing of ideas in the same way that music manages all sounds including intervals or silences because in harmony no isolated element can exist without relation to d 'others. "It is through the mutual intertwining of forms that discourse is born to us". (Sophist 259 e) Forms, according to the philosopher Plato, manifest the thoughts of God, reveal the way God thinks. We know God only in the contemplation of forms, in the same way that God contemplates Himself in forms. The cosmos as a whole includes not only the world of ideas but also the sensible world of forms, the two being inseparable. The Universe is indeed a structured organism.

The principles of this structured world are, according to Pythagoras, numbers and their harmonious relationships, as perceived in geometric shapes. From the monad and the indefinite dyad are born the numbers, and from the numbers the points, from the points the lines which engender the plane figures; the plane figures engender the three-dimensional figures from which are born the sensible bodies composed of four elements (fire, water, earth, air) which are transformed into each other. The nature of the number is the decade, whose power is contained in the number 4.

These statements of Pythagoras are so new for the time that they must be kept secret by his disciples on pain of death. Several indications let believe that he would have composed his philosophy according to the account of the shamanistic clairvoyances of Salmoxis, his slave. With Aristeas, Abaris, Epimenides, the hypothesis of a Greek shamanism tends to prevail. The Greek citizen acquired the certainty of this with the epic poems (Iliad and Odyssey) of Homer and the great religious poem (Theogony) of Hesiod.

Influenced by Pythagoras, philosophers will deduce that men had to imitate this order of musical harmony and mathematical laws because it emanated "from a living creature endowed with a spirit and an intelligence" (Plato) whose Wisdom is revealed by "a perfect order of the All" (Cicero) and Nature as a work of God teaches men the order necessary for its accomplishment (Aristotle). God is cosmic.

Theos (Xenophanes) marked the beginning of the separation between God and Nature. A few years after Xenophanes, Heraclitus

seeks "to know the Thought that governs everything and everywhere" and conceives in his quest the logos, eternal reason as the foundation of all things. Following these metaphysical reflections, Anaxagoras deduces a concept which unifies both the theos and the logos and which he called the noos, a capital term still today, the famous noosphere, which designates the unity of thought. , of the intelligence and of the spirit which gives to the Universe its order and its beauty.

Henceforth God is both the cosmos unified with the nature of the archaic traditions and a transcendent Being, the trinity theos-logos-noos creator of Heaven and Earth to which man and all things are subordinate.

Between 800 and 200 BC, a prodigious intellectual revolution took place, crossing China, India, Persia, Palestine and of course Greece. This period, described as "axial" by Karl Jaspers in Origin and meaning of history, represents a pivotal moment when the principle of individuality bursts into history. Man discovers an interiority that places him alone before the creator; behind the collective destiny manifests a personality that seeks to merge with the divine. This intimate relationship with an interiorized divine allows communion between the greatness of God and the autonomy of human thought and opens the door to the philosophical understanding of what God wanted to do.
Socrates (470-399), very happy to discover Anaxagoras' concept of noos, begins to read his work only to come out immediately disappointed. Indeed, the physicist was content to speak of intelligible cosmogony without addressing the beneficial consequences for the being. Resolutely, Socrates took sides for the ethics of good, that is to say, he is convinced that the noos as supreme intelligence has endowed his work with the best possible dispositions, such is Providence. God only wants the good but man is nevertheless responsible for his choices. He then lays the foundations of an idealistic and dogmatic system which slides towards the moral domain: to know oneself, to take care of one's body and to act adequately according to the gods. Following him, Plato and Aristotle will take the pilgrim's staff. The sky and the earth form a Nature where at the top sits the idea of Good according to Plato or the pure Act, as Aristotle would say.

So originally, cosmos/nature, spirit/knowledge formed a whole but, with the introduction of the concept "cosmos = living being" by Plato, quietly will arise the concept of the Supreme Being and its corollary, the idea of creation. Plato (428-348) will make divine goodness the first cause of our existence because only the goodness of the celestial "Father", the poiètès, the "maker" allowed order to emerge from disorder. "It is indeed impossible for the Being who is the best to produce anything other than the best," he asserts in the Timaeus. He holds the idea of his master Socrates who maintains that, from his own point of view, every man seeks what is good and believes he is doing what contributes to it, no one seeks what is bad.

According to Plato, our world becomes a living order oriented by the Socratic Good whose soul contains Pythagorean harmony in the musical sense. The harmony of the Soul of the world becomes the symphony by which the elements of the world and the movement of the heavens agree and where Good largely prevails over Evil. One of the difficulties that ancient philosophy comes up against is that nature is the place of the accidental: the best example is the existence of monsters. On the other hand, nature is not completely given over to chaos, an order emerges from observation: "nature does nothing in vain or superfluous."

Aristotle (388-322), inspired in turn by the work of his master Plato, will make the search for knowledge through the contemplation of the visible and the sensitive, the basis of his spiritual quest. Aristotle builds his philosophy from the observation of physical realities, the most penetrating of which is that of the perfection of the movement of the cosmological order which designates a source, the primary reality of a primary being: the divine as Source of intelligibility. of the Universe, as a pure act of existence.

Almost all of the schools of Greek thought recognized a divine Principle linked to the natural order, but from now on the divine Principle will be either immanent in everything as in Aristotle and the archaic traditions or transcendent as in Plato and the monotheistic religions.

The dissenting school will be that of the atomists (Leucippus, Democritus, Epicurus, Lucretius) which will inspire modern science - being is an infinity of atoms - for whom the natural order is not of divine origin but corresponds to the interactions of atoms according to a law "known as the conservation of nature", - nothing is lost, nothing is created - cosmic, mechanical, mathematical and atheistic law. Atomism presents itself as a natural law stripped of all supernatural interference and its followers will become the fiercest adversaries against the deification of the stars and the world in general. Epicurean morality seeks to establish peace of mind through the rejection of religious superstitions and the serene acceptance of the vagaries of life. But beyond this observation, it is important to point out that the entire philosophy of the atomists is limited to the sensible world; what is offered to our senses is the sensible world, which Epicurus stops at the stars, since the stars stop sight. So that the central point of the analysis is not the infinite totality of the Universe but the world that we perceive, the atomist tries to explain why this world is like this and not otherwise. The founding element of this world is the atom, a solid body bathing in an ocean of emptiness. The whole is body and void as infinite as the void and the number of atoms. The atomists' intuition is brilliant, except that the problem remains: where does the atom come from? What are atoms made of?

From the Greek atomists, the thought is divided into two currents: that for which the harmony of the Cosmos rests on a divine Intelligence (transcendentalism) and that which teaches that all is matter and rests on the law of chance, moira, of fate. (materialism). Nevertheless all these schools shared the idea of the existence of an order in nature and governed by a law of the cosmos, either the Moira or the Logos or the Theos or the Noos from which emanates a moral order which governs men. and their societies.

Thereafter, the transcendental monotheistic biblical religions progressively dissociated the divine Principle from the natural principle. Because the Jewish religion by enthroning Yahweh as unique God also created the History of the world with a beginning, a direction and an end. Then will come the Christian God and the Allah of the Muslims, all tribal gods with a universal but earthly propensity. Religions have therefore had a virtual monopoly on cultural concepts for almost four millennia.

Then came scientific knowledge. Physics is the science that allows us to understand and explain the phenomena of the Universe. If consciousness is part of the Universe, then physics - and more specifically the laws that govern the "quantum world" - could reveal its nature. Where general relativity is interested in the infinitely large, quantum mechanics studies the infinitely small and the interactions between particles on a microscopic scale. As a reminder, the laws of quantum mechanics make it possible in particular to understand atoms and molecules.

Quantum consciousness: myth or reality?
According to physicist Emmanuel Ransford, "it could be that the world of the atom and the electron is imbued with a psychic dimension capable of interfering with tangible matter". This implies that there would exist a quantum consciousness, that is to say that quantum phenomena (such as the entanglement and the superposition of states) could explain the emergence of consciousness. Indeed, according to this controversial hypothesis, classical physics, memory points are therefore at the origin of consciousness, and therefore of culture.

The circulation of information through culture takes the form of a spider's web that the development of techniques gradually makes coextensive with the world. Thus the microtubules of the brain form-

ing a network of neurons would then be the equivalent of the network of vectors criss-crossing the Universe. This new theory proceeds from the same vision as panspermia, namely the dissemination of life from place to place in the cosmos...

The panspermia theory is one of the scientific theories proposed since the 19th century to explain the existence of life on Earth. This theory - which had several variants - was in fact very old: Anaxagoras, the great Greek philosopher, had already proposed it 2,500 years ago, even giving it this name. In fact, it does not explain the origin of life itself, which would have appeared elsewhere than on our planet, somewhere in the Universe, after which it would have spread according to more or less known mechanisms.

To better understand the scientific theory of panspermia, let's recall its historical context. Darwin had hypothesized the origin of life, in a letter, in these terms: "It is often asserted that the conditions permitting the first production of a living being are just as well met now as they are have ever been in the past. But if (and oh! what a big if) we could conceive, in some warm little pond, in the presence of all kinds of sals of ammonia and phosphoric acid, of light, of heat, of electricity, etc. that a compound of protein was chemically formed, ready to undergo even more complex changes, today such matter would be instantly devoured or absorbed, which would not have been the case before the appearance of the living creatures."

He thus opposed the argument put forward to refute a spontaneous appearance of life, implying that the process, if true, must be observable today. This idea inspired many biologists and chemists in the decades that followed. But did this warm little pond necessarily have to be on Earth? If not, a way had to be found for life to be transported from its birthplace to our planet. One could therefore imagine spores, or the equivalent, bringing life throughout the Galaxy, traveling from exoplanet to exoplanet, driven by the breath of starlight. We would therefore be "stardust".

Reverse Panspermia

Extraterrestrial life could indeed exist, we know it... But would its origin be the Earth, quite simply? The impacts of celestial objects on the surface of our planet would have "thrown" bacteria into space.

We take up the story of life, upside down. According to a well-established theory, bacteria or more broadly organic molecules fertilized the Earth, transported by meteorites and comets coming from space. This is the famous theory of panspermia, launched in 1905 by the Swedish physicist Arrhenius. Imagine the opposite: the Earth could be at the origin of the propagation of life in space, or in any case be a relay. Imagine the hundreds of billions of organic molecules propelled into our galaxy when colliding with the planet Theia.

Researchers have computer-simulated the ejection of terrestrial matter following an imaginary shock of the magnitude of the one that caused a giant crater 65 million years ago off the Yucatan peninsula. (at the origin of the extinction of the dinosaurs).
The model makes it possible to track the millions of fragments born from the impact. Could some have reached Europa, Jupiter's satellite, or Titan which revolves around Saturn, whose conditions are deemed favorable for life? Although the probability is very low, the simulation has shown that over a period of five million years, a hundred celestial objects resulting from terrestrial shocks could have struck Europa, and thirty encountered Titan... That is enough to ask the question: did the Earth, bombarding its neighbours, sow life?

However, many issues were raised. Could these fragments travel far, and travel greater distances to reach the outer reaches of the solar system and sow bacteria there? Would transported bacteria resist both the acceleration resulting from such shocks, and the sudden and extreme rises in temperature? According to microbiologists from the University of Florida, who have carried out very high-speed impact tests on bacteria with NASA, this is quite possible.

Incidentally, man-made panspermia has already begun. While the Spirit and Opportunity Rovers have been scouring the red planet for more than a Martian year in search of traces of life, the environment close to rovers and probes sent to Mars in the past presents a high number of bacteria. Evidence of Martian life? Nope ! Simply, the proof of a contamination of Mars by the various missions which succeeded one another there. One billion ! According to the conclusions of an expert report, this is the number of bacteria spores transported from Earth to Mars during the many missions that have followed one another on the red planet. Of course, these are concentrated in their landing zone or were sown during their tribulations on Mars.

So let's come back to Earth.
The genome is the jolting stagecoach, breaking wheel after wheel, braving the opposing elements, progressing on the scale of a million years. Culture is formula 1 playing around with chicanery, accumulating knowledge so quickly that no encyclopaedist or university can know everything anymore, and far from it.

Even though culture is exploding around us, the genome still exists. We would be nothing without him. This means concretely that a man is at the crossroads of two sources of information. Our genome on one side, our culture on the other. A priori, one can think that these two types of information should not interfere. After all, why not admit that our genome has the blueprint for our skeleton, our muscles, our sense organs, and a few other useful structures, while culture is the source of our reasoning, our political opinions or religious, of our social behavior.

There lies the error.

Because there is a meeting point between genetic information and cultural information. This point is located in the cranium of every human. In the depths of the gaze of the other, is it the gene, the culture or both the gene and the culture that I glimpse? And in the battle between two schoolboys, is it the gene or the culture that clash?

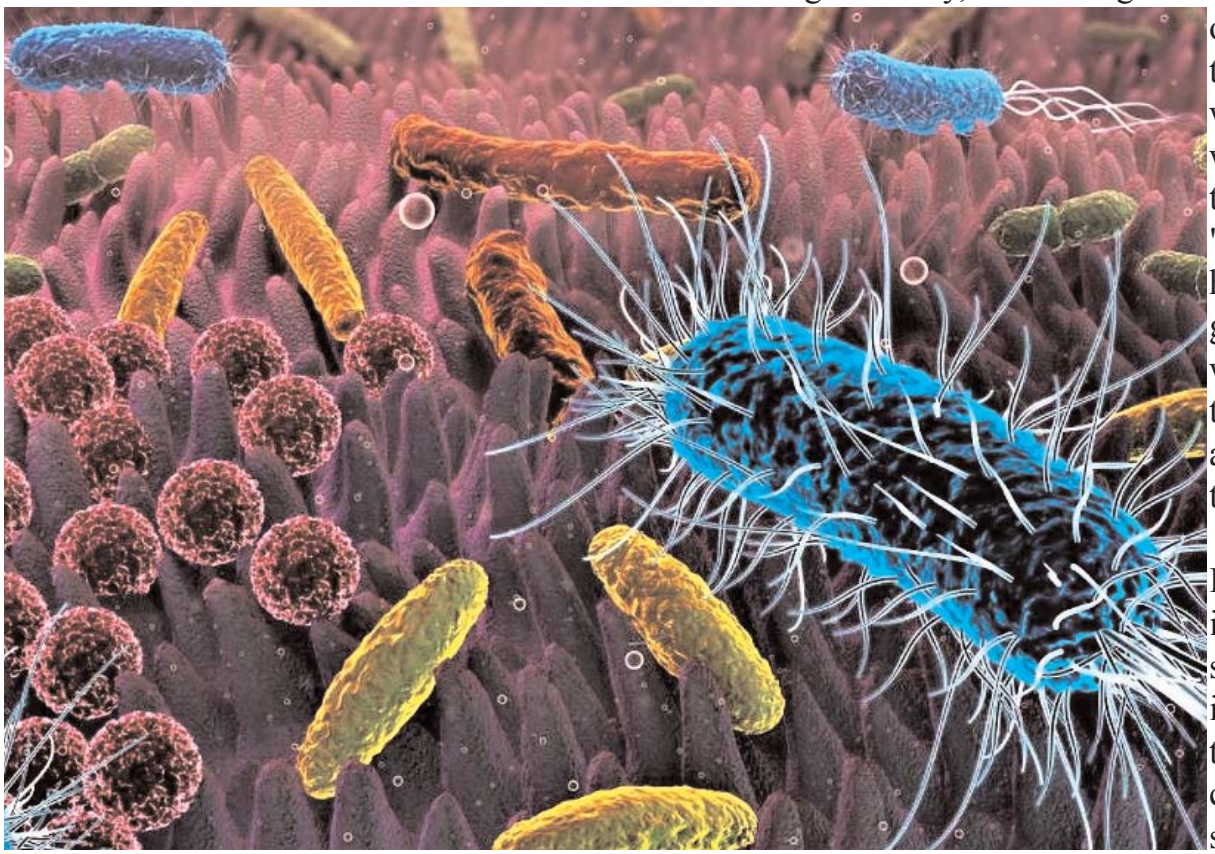
It is through entirely "Darwinian" processes, ie linked to the evolution of the genome, that the human brain emerged. No one is unaware of this increase in volume and complexity of the brain of primates since Lucy, the Australopithecus of 3 to 4 million years ago, up to modern man. Even if a "proto-language" may have existed in our primate ancestors and even if human culture is not the result of a sudden emergence (birdsong is also transmitted by learning), it It is thanks to changes in the structure of the brain that language and consequently culture are born. Man must accept to be a species among others (this does not mean a species "like" the others) in the tree of evolution. The theory of evolution, all the main lines of which were confirmed by the discoveries of molecular biology at the end of the 20th century, made man reintegrate into his natural family, even if this greatly shocked the contemporaries of Charles Darwin (man sometimes behaves like an upstart who would like to ignore his earthly origins and there are still universities, it seems, where one does not have the right to teach that man and chimpanzee have a common ancestor)

For biological evolution, good and evil cannot make sense. That the wolf devours the lamb is neither bad nor good, any more than the inevitable death of the wolf who ate the lamb. Good and evil are pure creations of culture. Good is everything that opposes natural laws and evil, of course, is natural laws themselves. The fantasy of a world built on laws other than those of nature is nowhere expressed so well as by the imagery of the Christian paradise, in which the wolf eats grass and fraternizes with the lamb, and where all other predators have ceased to pursue their usual victims.
However, it is not the fate of the lamb that seems most unfair to humans. The constantly renewed (and constantly disappointed) hopes of humanity are addressed to the relations between humans themselves. Let the wolf be a wolf to the lamb still passes, but, God, let man not be a wolf to man! Or rather, we men make man no

longer a wolf to man. Thomas Henry Huxley already wrote in 1893: "The thief and the murderer follow nature just as much as the philanthropist" "The ethical progress of society depends, not on imitating the cosmic process, still less in running away from it, but in combating it ""The intelligence which has converted the brother of the wolf into the faithful guardian of the flock ought to be able to do something towards curbing the instincts of savagery in civilized men" philanthropist The ethical progress of society depends, not on imitating the cosmic process, still less on fleeing it, but on combating it. dominate the instincts of savagery in civilized man)

The wolf again!

Closer to home, the American biologist Laura Betzig wrote in 1986: "The laws of nature often have little in common with the way we would have them". have).



The "laws that we would like to have", civilizations have been trying to give themselves for several million years, civil laws, moral laws, religious laws. "Thou shalt not steal" is the archetype of these unnatural laws, the archetype of the laws our culture aspires to and our genome rejects. Here are the two pieces of information in conflict! The genome that says "fly" and the culture that says "doesn't fly". The DNA that opposes civilization.

The words "selfishness" and "altruism" have different meanings depending on the context. What is the biological definition?

Let's first consider a strictly genetic plan (the culture will come a little further)

The unit of selection on which the theory of evolution is based is the individual. If, in a population of a given living species, the individuals are perfectly autonomous and solitary, each seeks to obtain the best possible reproductive success, so that selfishness is, so to speak, normal. It has been going on for three and a half billion, and any biologist easily demonstrates to his students that altruism cannot be determined genetically, even though theoreticians have more than once tried to show the contrary. Indeed, any individual who would be altruistic would statistically increase the reproductive success of "the other" at the expense of his own. It is therefore the genes of the other which would spread in the populations at the expense of the altruistic genes, assuming that the latter exist.

If, unlike the previous case, individuals of a particular species live in groups instead of being solitary, things look different. One can make the following reasoning: if I live in a group, my altruistic behavior can benefit the group, which can ultimately benefit me, so my interest is to be altruistic. This apparently seductive reasoning led to the notion of group selection concept according

to which the unit of selection would no longer be the individual but the group of individuals. The groups in which cooperation between individuals would be most effective would be favored (thus positively selected).

Is war programmed in our genes?

Apparently yes, according to recent discoveries. The warlike propensity of chimpanzees is demonstrated for the first time in the June 2010 edition of the journal Current Biology. To reach its conclusions, the team of Dr. John Mitani, a primatologist from the University of Michigan, observed the behavior of anthropoids in Kibale National Park, Uganda for 10 years.

The objective of the primates is clear: to conquer other territories, notes the study carried out between 1999 and 2008. Several specialists had already observed the belligerent behavior of chimpanzees. The males then make a lot of noise and fight each other. Some die of it. But never had such a complex and intentional strategy been so clearly established at home, underlines John Mitani. "Every 10 or 14 days, they organize a battle in enemy territory. About twenty males advance to the edge of their territory. They walk silently in line before sinking into the opposing terrain. as well as the Ngogo chimpanzees advanced in a northeast direction and annexed 22% of the territory there, explains the researcher.

The monkeys react in two ways, according to his observations. Either they retreat in front of a larger group or they attack the unwary who crosses their path. This one will then be kept on the ground before being bitten and beaten to death. The attackers usually leave the female alive, but the babies will be devoured, explains the specialist.

The war as tool of survival

The modus operandi is essentially aimed at the appropriation and control of additional fruit trees, the research reads. The males thus ensure the females access to more food, thus promoting their fertility. These can then give rise to more resistant offspring, the group multiplies more quickly and improves its chances of survival.

"In this context, war becomes a form of adaptation, a behavior inherited from natural selection and programmed into the neural circuits of apes to ensure the survival of the species."

This research also highlights two particularly interesting aspects. On the one hand, the aggressive behaviors of monkeys and those of humans go back to a common ancestor, having lived about 5 million years ago. An important element to understand the human inclination to attack its fellows, according to specialists.

On the other hand, in their guerrillas, chimpanzees acted cooperatively to achieve victory. A reflex arises from evolution to favor the survival of the group before that of the members, reports John Mitani. This thesis contradicts the generally accepted understanding of natural selection, which privileges the individual in the reproduction of the species instead of the group.

In view of the immense confusion and the very many controversies to which the biological foundations of war and peace have been the object - between neurobiologists, anthropologists, psychologists, political scientists and others -, it is therefore important nevertheless to try to clarify things. The origin of the confusion is as follows: it is generally assumed that if large-scale murderous violence has always existed, it is because it is the result of an "irrepressible" primary biological drive which is practically impossible to evade. Many see this conclusion as reason enough to assert that the human propensity to fight is as old as the species itself, while others see it as irrefutable proof of the inevitability of war. But both are wrong. Contrary to the notions in vogue in the 1960s, which go back to Freud's last theories on the drive or the death instinct, violence is not a primary drive that requires a form of release, like anger. or sex.

On the other hand, the fact that violence is not a primary drive does

not mean that it cannot be deeply rooted in us. Different studies carried out on "peaceful" pre-state societies generally tend to demonstrate that war is neither essential nor innate to the human race, but that it probably depends on a recent cultural phenomenon, and in any case , entirely fortuitous. The way Margaret Mead approached the problem in her essay Warfare Is Only an Invention-Not a Biological Necessity, published in 1940, was a very big mistake. This approach echoed the widely held principle that violence is either a primal drive or an entirely learned behavior, when in fact its potential manifestation is deeply embedded in us as means or tool that we can use at any time. To achieve our goals, we may cooperate, compete peacefully, or resort to violence, depending on what we believe will best serve our interests under the circumstances.

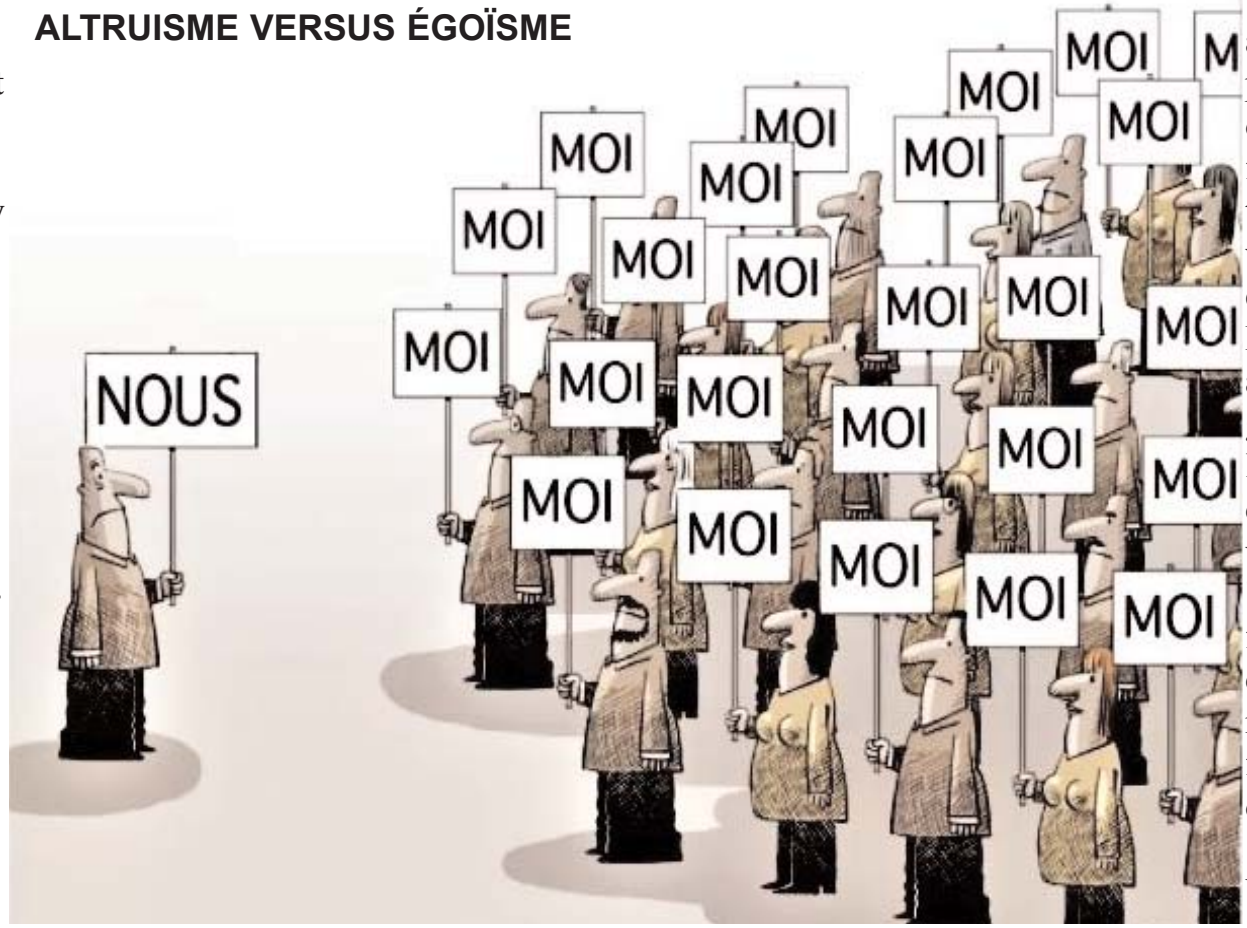
In the case of cooperation, the parties combine their efforts, because they consider that, in principle, the result of the synergy of their individual efforts will be greater than the sum of their individualities. In a situation of competition, each of the parties aspires to surpass the other in order to achieve a targeted objective by employing all the means at its disposal, with the exception of direct action against the other. Competition thus implies parallel actions. Conversely, in a situation of conflict, the parties resort to direct action against their competitor, either to eliminate it or to reduce its ability to oppose. When this conflict involves physical harm, it is then qualified as violent.

Cooperation, competition and conflict are the three basic forms of social interaction. Stakeholders have therefore always had a choice among these three options and they have always assessed their specific situation to decide which option, or combination of options, offers them the greatest chance of success. We are biologically equipped to apply any of the aforementioned strategies, and conflict is only one of the tools in our toolbox, even if it is one of the main ones: the hammer.

Furthermore, Homo sapiens is a highly sociable species, whose local and regional groups - universally and uniquely linked to each other by kinship ties and cultural codes, including language and customs - are prone to cooperate through a large number of group activities. These activities include combat, which is initiated with the aim of achieving a common goal, with the conquest of territory and food as a priority. Our propensity for conflict has thus been shaped by our evolution and is an integral part of our behavioral spectrum: it is therefore neither a recent invention nor an irrepressible impulse independent of external factors. It can therefore be concluded that both war and peace are ingrained in our genes, which explains the great variability in their prevalence in different socio-historical contexts. As rightly stated in the "Seville Manifesto on Violence", adopted in 1986 by an international group of scientists under the auspices of the United Nations Educational, Scientific and Cultural Organization (UNESCO): "it there is nothing in neural physiology that compels us to react violently. […] We proclaim in conclusion that biology does not doom humanity to war". The Manifesto thus rejects the idea that violence and war are intrinsically linked to human biology and are therefore inevitable. However, in doing so, this Manifesto falls in the opposite direction, proclaiming that war is a "product of culture" and solemnly describing that "IT IS SCIENTIFICALLY INCORRECT to say that war or any other form of violent behavior is genetically programmed into human nature" (capitals in original). The manifesto concludes that "violence is neither inscribed in our evolutionary heritage nor in our genes". In reality, we are endowed with both a propensity for peace and a propensity for war. Although activated interchangeably and jointly in response to overall environmental and socio-cultural conditions, these three behavioral strategies - violent conflict, peaceful competition, and cooperation - are not strictly acquired cultural forms. The simplistic nature of this innate/nurtured dichotomy omits the complex biological mechanism necessary for the operation of each of these behavioral strategies and their interaction. To be sure, these patterns, deeply embedded and shaped by evolution, are variably adjusted through social learning to particular circumstances.
However, the reason for their presence in us, as well as our ability to

activate them with ease, is that they have served us well over our long evolutionary history. These models have all proven to be extremely effective and beneficial, and have thus become full-fledged tools of our biological equipment. Wars have been waged to obtain, through violence, objects of desire analogous to those which man pursues through his general motivational system. Politics, national and international, is designed to satisfy these desires shaped by developments at the intra- and inter-state level. The theoretical principles governing international relations have gradually lost sight of human objectives to explain the engine of conflicts and wars. They focused almost exclusively on the presence of "favorable conditions", such as international anarchy (which has ceased to lead to war anyway between countries participating in political and economic liberalism, in North America and Europe). western). It is also wrong to say that all parties to an armed conflict are losers or are "tragically" trapped in a kind of prisoner's dilemma: this assertion amounts to another major error, characteristic of theories of international relations.

ALTRUISME VERSUS ÉGOÏSME



Although all types of prisoner's dilemmas can be present in conflict situations, human history has had many losers, but also many winners. On the other hand, certain human quests, such as domination or ideology, are not "demons" to which we must systematically attribute the responsibility for a war. Domination or ideology, in the same way as the desire for love and sex, can just as well be put on the side of the "angels" when the quest involves the use of pacifist means, for peaceful ends. .

The distinctions that Pinker establishes between the different categories of violence, which he associates respectively with the "demons" mentioned above, are also questionable. In particular, he cites a series of studies showing that different parts of our brain can trigger violent behavior, which is also true for practically all types of behavior. But that doesn't mean that all violent behavior isn't governed by a unified evolutionary process, originally designed to encourage survival and reproduction. The "problem" of war is therefore not the presence of desires in man, which determine us as such, which form one of the components of human life.

Violence and war arise when conflict is seen as a more "promising" behavioral strategy than peaceful competition and cooperation for achieving human objects of desire. Our fundamental desires on the one hand, and the conditions which determine the efforts which will make it possible to satisfy them on the other hand, are both necessary to understand the reasons for the appearance of a

war.

From the Mesolithic and then the Neolithic, the instinct of domination was grafted onto the instinct of life and parasitized it to the point of instilling in it the venom of oppression towards its fellow creatures.

This new fundamental power will be actualized in the repression and the domination of the social corpus by the patriarchy which it will erect for a long time, patiently into a political system.

"We know (...) that sexual dimorphism (sets of characters not essential for reproduction and which make it possible to distinguish the two sexes of a species) is rooted in the processes of reproduction and socialization of primates (...) During the evolution of humanity, this basic "pattern" was enriched by the complex behaviors developed by hunting. (...) The existing sexual differences were further accentuated. (...) The one of the most important consequences of hunting as a mode of existence was to accentuate the difference between the behaviors of men and those of women.... If we remember that at this stage of the primitive civilization of the hunting, the size of the brain goes from simple to double (...), we can take the measure of the processes that selection then implemented and which must have been enormously effective. of primates has been transformed into an impressive new structure, that of cooperative hunting. (nda- origin of diplomacy (alliances). From this also follows that politics is a "man's business", with its intimidation behaviors, its phraseology, its written regulations, its vanities, its bizarre conceptions of the honour: we are afraid of appearing weak, we are disposed to fight and war, we flaunt manly grandeur and self-exaltation (...) These selection mechanisms have influenced the behavior of all masculine types and produces those extravagant but very real results which seem so dear to the ego of men." (Tiger and Fox, The Imperial Animal, p.121-122, 1971.)

Several psychoanthropologists are beginning to wonder if the initiation ritual centered on separation and the causes that provoked it, are not themselves the psychological origin of the oedipal conflict. So much so that the Oedipus complex would be as much cultural as natural and would have served man since the prohibition of incest meets this double requirement of separation and hierarchy of control by subtracting the male from sexual power (seduction/fascination) of mother and sisters. Thus the male would have converted into an exclusive cultural advantage a natural process guaranteeing the good physiological and psychic health of the species. How and why ?

Men through initiation finally reveal to males the power of their sex in comparison to the negative and isolating power of women not only with regard to sexual relations (incest) but in all the details of daily life (avoidance and isolation due to menstruation). Having become the guardians of their society, they will henceforth have the right to impose discipline on women and young people in order to thwart all attempts at autonomy. All the initiation rites confer on the male the necessary authority over the woman by propelling male superiority into the order of the sacred.

To achieve this, the young pubescent male must undergo trials and ceremonies. The sometimes cruel tests are of a physical and moral order because he must show endurance and virility. To ensure the group's cohesion and durability, the adults make it feel their authority in various ways while giving it detailed instructions on its future role. The adult reveals to the young boy his deep identity while confirming the disfavor that strikes the female sex. Initiation detaches the boy from the mother, sometimes he is forced to leave his hut, his mother no longer has the right to see his penis. He is ready to marry, has the right to sit and eat with the men, he can take part in the trial, give his opinion and go to war.

Initiation is a killing, that of the child, and a birth, that of the adult. The man seizes the child from the mother, appropriates it and gives birth to it as a man. By the negation of birth conferred on the mother, the man legitimizes his superiority, withdraws the power of

maternal power from the woman, appropriates it. Then occurs a mysterious mystical and sacred alchemy where man becomes both social mother and natural father. The woman can only bow before such magic: the man alone has the capacity to engender adult sons. Successful initiation undoubtedly demonstrates the conquest of man over woman within society, and the latter, under the threat of psychological terror and physical coercion, is called upon to honor this rebirth as a pact that submits it within the family and the group.

In the Neolithic, hunting having reached its apogee and its limit, it was necessary to find complementary food (agriculture) and creative supply techniques (breeding) to cope with the population growth of the species.

Faced with this exponential population growth, the need to control these human beings quickly appeared and to regulate the dynamics and practices of community life. A whole collective construction of individuals, clans, professions, classes, races and nations is thus being built. The only model at hand was that of subjugating women by coercion: the despotic method reserved for women migrated to men of "lower class" or foreign to their ethnicity.

Repression occurs when the ruling classes impose their selfish will on those they dominate to deprive, exploit and crush the weak. Thus continues the logic of domination.

The first: the proletarians will be subject to work but free, the second subject to work but slaves supervised by warriors who ensure social cohesion and the defense of the territory and priests who ensure the spiritual tranquility of the soul in exchange for fidelity time in power. The despot man vis-à-vis the woman will continue his search for power by totalitarian barbarism towards the other impure to his ethnic group. The discrimination of men against women based on the fear of sexuality and the powers related to fertility, sexism, has therefore served as a model in the construction of the concordant elements of totalitarianism and despotism between men themselves. : racism and slavery.

The impurity of the woman polluted by menstrual blood will be succeeded by "the smell, the color, the texture of the skin, the shape of the face, the crimping of the hair" like so many stains, tangible signs of suspicion for the unavowed purpose domination of one group by discriminating against the other and who should be kept in an inferior position. (Moscovici, 1994)

This emergence of culture into human consciousness marks the end of "purely nature" man and the beginnings of man/culture. Moreover, it is there, at this precise moment, that the philosopher Kant locates the appearance of evil. This progress of the species breaks the determining instinctive links and causes man to leave the natural order (paradise, the golden age) and founds the now famous opposition between nature and culture, between good and the evil. Kant concludes from this in Conjectures on the beginning of human history that "the history of nature begins with good because it is the work of God; the history of freedom begins with evil, because it is the work of man." Man loses his original innocence through the awakening of reason, which Kant associates with the "biblical fall". Thereafter appeared the evil inclination of man for vice and its attendant evils.

This evil inclination, Kant l 'called "radical evil". This concept only applies to human reality because Spinoza will later establish that nothing is bad in nature because all things are in conformity with what they are and that the perfection or imperfection of things, of beings are strictly human modalities of comparison which refer to no other reality than that of their imagination of an ideal model.

By destroying his own life and that of others, the guilty man experiences the whole panoply of psychic despair, physical destruction and psychological wickedness is the fall into evil where in an ultimate attempt to end existential angst, it accelerates the process of self-destruction of freedom itself Suddenly he realizes that man is

not what he should be, that his life is an aberration, an alienation dictated by the fear of death.

All the myths will tell in the form of a story the passage from purity to defilement and will try to explain the why of social prohibitions and their necessities as a regulating process of human destiny. Thus, state authority and coercion has skewed the spectrum of human behavioral strategies toward peaceful options at the national level. Let me add in conclusion that changing economic, social and political conditions are having a similar effect internationally, especially where economic and political liberalism prevails and options for peaceful behavior are much more beneficial than the violent option.

On the other hand, the concept of group selection does not have many supporters among contemporary geneticists, and this for a reason that surprises at first sight: because of cheaters. It is in fact easy to demonstrate that if, in a supposedly cooperative group, certain individuals reap the benefit of solidarity (accept help from others) but refuse to pay the price (do not help others), these individuals are favored by natural selection. It is their cheat genes that, statistically speaking, spread through populations and destroy group cohesion.

Cooperation also exists between organisms belonging to distinct species, therefore carriers of entirely different genetic information. It is even the difference between this information that makes them complementary and explains why this type of association has been retained by selection, on several occasions during evolution. The most familiar cooperation of all associates flowering plants and insects: the plant feeds the insect with nectar; in exchange, the insect transports the pollen from one flower to another and thus ensures cross-fertilization, which is essential for maintaining genetic diversity. However, the impression of harmony, even altruism, that these cooperations give results from a projection of our fantasies.

Genetic studies show that, in a plant-insect association, each of the two partners is perfectly selfish: the orchid has no objective to feed the bee or the butterfly; the bee and the butterfly do not seek to render service to the orchid. Moreover, there are also cheats in this type of association: we know flowers that attract insects but do not give them anything in exchange for transporting pollen, we know insects that taste nectar but do not transport pollen !

Everything seems to prove that this praise (and this necessity) of selfishness applies to all living species that inhabit our planet All species ??? Except one, shouts the honest man! Really ?

If according to Pic de la Mirandole, "one is not born a man, one becomes one". The dignity of man is due to his freedom, he affirms: there is not a human nature first, but a movement, a kind of native power, by which man decides and realizes his essence. That is to say that man is not born man but becomes one, as if he were his own creator: thereby he takes from God. What makes man specific is his existence, his freedom, this power to give himself, by himself, an essence.

To be is therefore to make oneself, to construct oneself over the course of our knowledge and experience. These, then, are the precepts of a concept that was called altruistic humanism of a pacifist nature, a cooperation which will experience phenomenal expansion and which will be fought against by selfish cheaters.

Biggest cheater: the alpha male

Because hunting and sharing food induces knowledge of material things, For example, the hunter is the first to understand that food has a value in itself, as if this external and natural thing because necessary also referred to an internal reality what is the desire of the thing. Instinct is also desire.

The desire to possess food, the desire to procreate with the woman gives his instincts an exchange value. Will follow the installation of a behavioral structure based on the exchange: the system of barter to which the woman was quickly integrated like commodity. So it is wrong to say that prostitution is the oldest profession in the world. Lobbying and pimping preceded it when a secondary male pressured the alpha male to give him his dream female in exchange for more food. The male brotherhoods respond to the solidarity needs of males towards the fulfillment of their responsibilities, even in spite of periods of shortage or accident.

"To give and to receive, to make available to others what is one's own are the imperatives of an agreement which guarantees each man to be the partner of another man. Otherwise, there is neither well-being nor survival." In several ethnic groups, the woman is part of what is made available to others, the sexual act being considered as essential as food.

The subjugation of women by her companion despot is the primordial act of domination on which rest all the social forms (totalitarianism, feudalism, industrialism, capitalism, communism) engendered by "civilization" and all founded on domination. And now we know why: because living in egalitarian and non-repressive conditions with women was impossible because of the immense power that nature had bestowed upon them.

The society of men became the mechanism of repression of the male/culture towards the female/nature. And need we remind you, the right to vote for women appeared in the 20th century, nearly 2 million years after the first hordes of archaic hunters responsible for this "logic of domination." (Marcuse) Even today (2022), pay equity between men and women is non-existent even in democratic regimes.

Originally, men lived free until an external event, an attack or a ruse came to enslave them. The transition from freedom to servitude then stems from an accident in human history which caused the division of society. It corresponds to the birth of political power within the clan. The servitude of those who actively support a leader capable of saving them. Thus voluntary servitude becomes a resignation of a people who have forgotten the natural character of their freedom, living their servitude as second nature. Other men then come into the world and have never known the state of freedom in which their elders lived and are even unaware of its benefit. Men have forgotten that they were once free and that it was part of their most natural right. It is then the custom of domination which is the first chain of servitude. Men know nothing except that they are subjects: it has always been so.

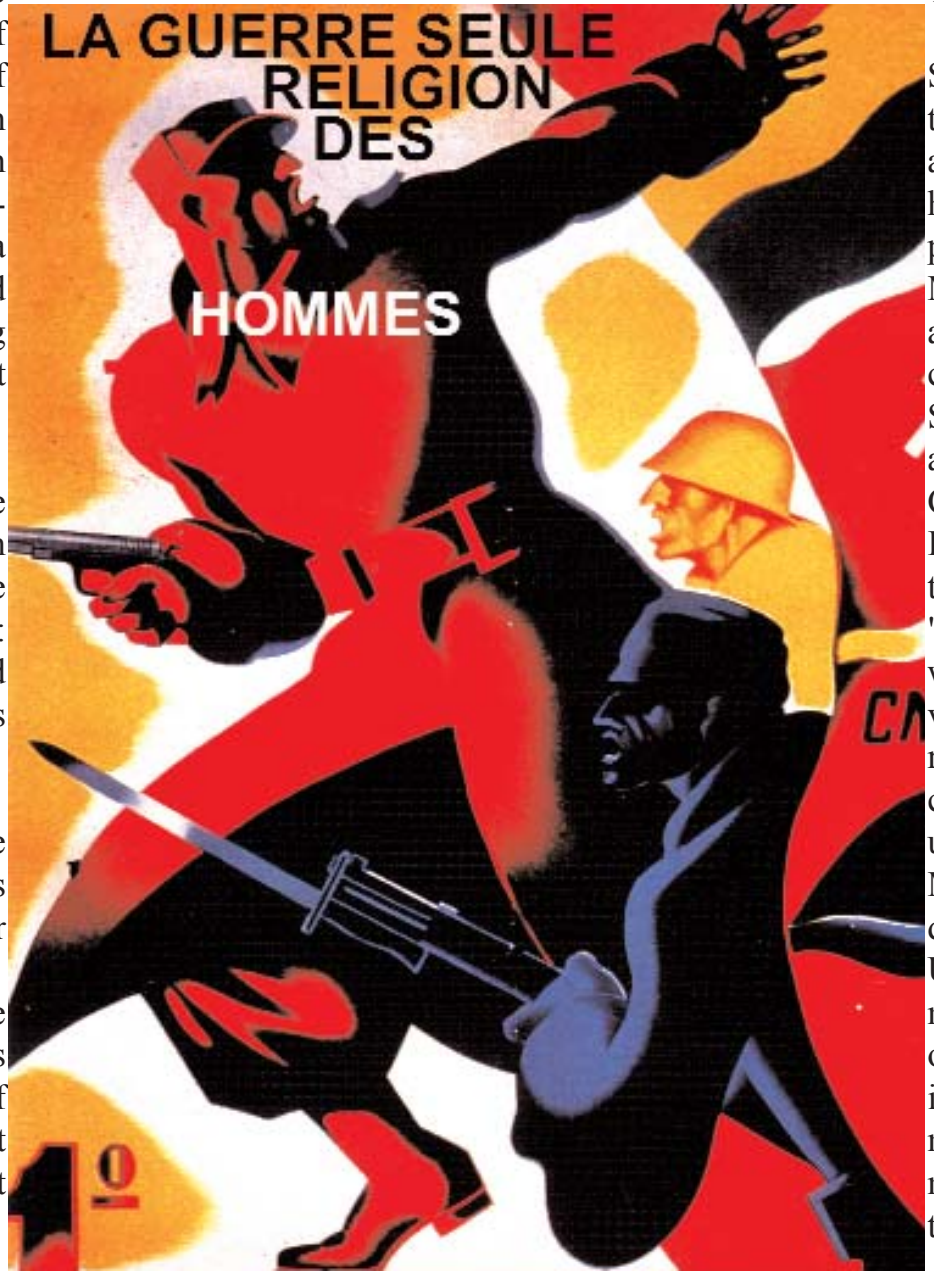
Thus these fraternities everywhere exert a great ascendancy and enjoy a great prestige on which rest the ideology, the economy even, the policy of the social groups. The deliberations are discreet and jealously kept out of reach of female ears or the uninitiated. Often the bonds woven between men are superior to those established within the couple, thus designating the real place of women in the social chessboard. "An economist calculated that women occupied an inferior position in 73% of agrarian societies and in 87% of pastoral societies." (Moscovici)

War: the only religion of men

The invention of total war

Assyria emerged in the 3rd millennium BC on the mountainous slopes of the Zagros Mountains, north of Mesopotamia and the Tigris Valley.

Its poor populations first made allegiance to the city-states of Sumer. Then to the empire of Babylon. They forge their energy in incessant battles against the Western powers, the Hittites, an Indo-European people living in Asia Minor (present-day Turkey) and Mitanni, a Semitic-speaking kingdom located to the west (present-day Syria).



On different occasions, for more than a millennium, the Assyrians in turn subjugated a large part of the Middle East, inventing "total war": surprise attacks, torture and massacres of prisoners, deportations of defeated populations.

Thanks to writing, the chiefs of the Sumerian cities transmit their orders more easily to their soldiers and their deputies.

No one can pretend to ignore these orders. The authority of chiefs increases and leads to the birth of real states with an efficient administration and obedient subjects.

During the third millennium BC. J. - C., the city-States of Sumer do not cease fighting between them a little like the urban republics of Italy of the Rebirth. These rivalries will cause their downfall.

Around 2300 BC. J.-C., the region of Sumer is submitted by a conqueror from the country of Akkad, in the north of Mesopotamia. This is Sargon 1st, king of Agadé.

Sargon the Elder (2325 BC) is therefore the representative of the gods on earth and his people must serve and venerate him as such. Sargon 1st, the all-powerful father-king of the Mesopotamian empire, is a terrible ambitious man. In a few military campaigns, he subjugated the Sumerians, arrived in the North as far as Lebanon, in the West as far as Cyprus, in the East as far as Elam in Iran. He is the one and only master of the universe and proclaims himself "masters of the four regions of the world" and of the "totality of men. This vision of the universal reign represented by the "cross" of the four cardinal points crossed all civilizations up to China. Athens, Rome, Jerusalem, Mecca will all define themselves one day as the center of the world.

Under his reign, Babylon acquires the mythical magnificence that we know of. The laws, the norms, the decrees, imparted to the gods who power over men, recognized by men, exercised by men, but reinforced and guaranteed by the gods.

Never before has the individual been lowered to this point in any other civilization. The fundamental goal being to reduce the individual to the most humiliating spiritual and temporal servitude. Not only does man no longer recognize himself but no longer even recognizes the other, his brother, like a Cain who only sees the other as a mortal threat; fear radicalizing into murder.

How could the priests perform such a miracle that had never happened before?

With the Neolithic appears, as we have seen, different sources of food supply thanks to the techniques of agriculture and animal husbandry. Domestication of plants and animals then! And why not domestication of man as to being there?

And Nietzsche's Zarathustra to ask "what do these houses mean? (..) Can real men come in and out? The prophet, after reflection, "said at last with grief: "Everything has shrunk! Everywhere I see lower doors and my species must bow down to pass through them. "They have shrunk and keep shrinking. (...) Basically, they simply want one thing above all: that no one hurt them. Their virtue is what makes them modest and docile; thus of the wolf, they made the dog and of the man even the best domestic animal in the service of the man. (Thus Spoke Zarathustra, Folio, p. 209)

This observation will be taken up several centuries later by La Boétie in his Discours dur la servitude voluntary where he expresses the same observation in these words: power only exists with the consent of those over whom it is exercised.

A sedentary lifestyle puts an end to the "golden age". We are in the era of contempt for the sedentary. Savage hordes plunder the crops and exterminate the communities that resisted them. Men women and children are brutally killed or enslaved; the first genocides of humanity are committed and will serve as models for Nebuchadnezzar and many others until our days: genocide of the Armenians in Turkey (1915), holocaust of the Jews in Germany (1930-1945), ethnic cleansings in Bosnia, Kosovo, genocide of Tutsis in Rwanda and African populations in Sudanese Darfur covering the years 1990-2005.

The fear of nomads and the conflicts arising from two radical ways of living in the world, mean that the sedentary people need protection inside fortified villages. The freedom of the savage hordes is frightening. Following the example of the enclosure, the fortifications create protective barriers and, perverse effect, control barriers. Thus, internal enslavement is justified by the struggle against external enemies transformed into scapegoats. Such is the price of security: it encloses the individual and the animals in the same house. The country is then covered with cities; this leads to the creation of kingdoms which bring together several cities under the authority of a single one. Rivalries between kingdoms lead to war and favor the creation of Empires under the aegis of the winner.

City-states are therefore fear-based communities and carry within themselves the seed of their destruction. It is with good reason that Lewis Mumford in The City through History shows that archaic civilizations possessed this particular advantage of promising protection against fear of external enemies; but to the very extent they thus seemed to promise a collective solution to the fear that reigned within them, they were based on violence alone and in turn spread violence and aggravated fear. (Drewermann, The Spiral of Fear, 1994, p.330)

Thus men have been constrained by fear of submitting to religious domestication and the choice of breeding that leads to the behavior of domesticated animals, but above all, priests, friends gods and men, have appropriated the monopoly of human breeding. All order needs power. Mesopotamian model of domestication/reduction of being that still exists; as evidenced by the history of our Christian missionaries in the Americas:

"The reductions are territorial enclaves where Aboriginal converts to Catholicism can settle alongside or among French settlers. The reduction is a project of Jesuit missionaries to convert and subjugate Native American communities. The reductions are created in Paraguay by the Jesuits and propose a mode of colonization allowing the exploitation of the resources of Paraguay while ensuring the evangelization of its inhabitants: the Guaranis, the most populous nation of Paraguay. This implied that the freedom of the "savage" had to be reduced in order to tame him and lead him to Christian civilisation. The reduction of physical space is only the prelude to their reduction to Christian values through pious religious practice and the renunciation of any indigenous custom contrary to the rules of the Church. This model of evangelization of the Native peoples of South America will be taken up by the Jesuits in New France, the goal: to transform the nomads into perfect neo-French people who would be granted protection. Reductions are therefore part of the political process of any expansionist colonial state. The Jesuits will thus create 5 reductions for 5 Amerindian nations: the Algonquins, the Montagnais, the Hurons, the Iroquois and the Abenakis. The reductions are therefore the direct ancestors of the Amerindian reservations that we know today; the reductions giving priority to the salvation of souls under the French Regime and the reserves, under the English Regime, giving precedence to colonial economic interests. (Jetten Marc, Native American Enclaves: Canada's "Reductions" 1637-170, 1994)

Thus, the Neolithic village is replaced by an urban society with a pyramidal structure with the king at the top, then his administration and his servants, then the priests, the merchants and the craftsmen, finally the common people who are both farmers and soldiers. Since men are now grouped together in housing estates, violence can now be seen as a mechanism of internal political power, conquest and organized exploitation. The state legitimizes violence as a regulative principle for its own ends. So much for the physical, material aspect of the thing.

But again why do men choose to deliberately lock themselves in this enclosure. What are they so afraid of to endure the worst bondage? What in the gods have I done to deserve such a fate?

Offending body

The Mesopotamians (Sumerians, Assyrians, Babylonians combined) are seasoned astrologers. From their celestial observations is born an original cosmogony which will have phenomenal repercussions for millennia until today.

First comes the conviction that the stars are by nature stable, immutable, immortal and therefore divine. The world is divided into two: the perfect and divine supralunar and the imperfect sublunar because human, influence of the pure/impure of the Hindus. But the originality of the Mesopotamian astrologers lies in the fact that human imperfection comes from a stellar fall of the soul on Earth. Indeed by noticing the erratic behavior of comets, shooting stars, they construct the concept of souls trapped in chaos.

"Possessed by the inherent disorder of the world, it (the soul) loses its spherical shape and stretches like a comet. It will flow along the Zodiac, taking a layer from each planet: from Saturn, it will take its discursive intelligence, from Jupiter its militant will, from Mars its combative mood or aggressiveness, from the Sun, the senses and imagination, from Venus , the impulse of desires, the libido, to Mercury, the gift of speech and finally to the Moon, the sediment which will unite it to a body of flesh. Thus she will incarnate, falling into evil from body to body. (Marc-Alain Deschamps, This hated and adored body, p.45)

The soul is a "spark of the substance of the stars" which falls towards imperfection because it has faulted, transgressed the divine order. This fall in the body becomes its prison where it must purify itself again to regain its divine purity.

An astral theology emerges where the purification of the soul is a corollary to the purification of the body. The body begins to trouble.

And to the Mesopotamian high priest, who is also an astrologer, to declare that the human condition is what it is, prey to physical suffering and doomed to death, because these evils are the sanction of a fall from heaven and every fault is a transgression to an order of the gods. The evil that one undergoes is tributary to the fault that one has committed. Previously, in the world of prehistory, evil was associated with misfortune, that is to say, it corresponded to a fatality suffered by man (illness, failure, injury, death). Man found himself overwhelmed by events whose effects he suffered, for which he had no responsibility. In short, our ancestor could not intervene since he was immersed in ignorance of the sources of misfortune. He then discovered his powerlessness in the face of his destiny and felt a deep insecurity in the face of the outside world. From now on, the fault is contingent on the human species and each man bears this "original fault" by the simple fact of his belonging to humanity.

"We are turds fallen from the devil's anus. (Luther)

The whole Mesopotamian culture is crossed by the chaos of the world, by the violent debauchery of the enemy hordes which reveal to us all the ignominy of which man is capable, we come to think that evil is housed in man from a way so visceral that it needs to be tamed. Kant speaks of "Radical Evil. This evil, the ancient religion calls it the fall. The fall hypothesis implies that not only is man corrupt, but he is horrified to discover that he is afraid of himself.

Let us immediately dispel any intentional attempts at an organized conspiracy against the man. Rather, it was to first create a "logical" astral theology and second, to establish a socio-political context consistent with the findings of Mesopotamian astronomers. We measure the universe, the world, the man, the society only from the real knowledge of a civilization at a given moment registered in a precise time. The astral discoveries of the Mesopotamians were just as destabilizing for man as the theories of mechanics are for us today.

For the first time in the history of humanity, metaphysical Evil appears in the cosmos in the guise of the God Kingu; which means that the nature of man, son of Kingu, is essentially evil and demonic; Evil is in his flesh and is called freedom. This wild, bestial freedom frightens and arouses inner anguish because man knows fundamentally that freedom offers dizzying possibilities and can also make him regress into animality. It is in front of himself that man experiences anguish, including the shame of not being able to properly assume his freedom, such is the meaning of the fall. Seizing on this anguish, the Mesopotamian clergy present themselves as the only ones who can "liberate" man from the dread of his own freedom. This Mesopotamian account has just created "the original fault. There follows a whole series of precepts, rituals and incantations that man must observe to purify himself.

From birth to death, man becomes hemmed in on all sides by religion; but for what purpose? Let's go back to Mesopotamian mythology to discover its meaning. One day, Nammu, mother of the god Enki, god of the waters, complains about the painful labor imposed on the gods. Enki then offers him to create puppets who would do the work for them. From the mud of a sacred river, Enki thus created the human race to serve as slaves to the gods and therefore to the despot king who represents them on earth. A Marxist would see there the birth of the proletariat.

Moral submission to the gods and even physical submission to the king through work are then perceived as the purification necessary to cleanse the stain of fault.

Aside: Did you know that, at the entrance to the Auschwitz camp, it is written: Arbeit macht frei, work makes you free. "

These syntheses of cosmogonies, theogonies, social and racial categories that merged at this time are capital mutations that allowed the constitution of nation-states, as in Mesopotamia, Egypt and Persia, headed by men-gods. . In fact, these nation-states act as a humanitarian system that protects the entity against external aggression, a sort of survival strategy for the species to use a comparison dear to Darwin. But each of these nation-states of theocratic type taken in isolation introduced the notion of national religion related to a strategy of clan or tribal survival and became a source of division and an issue of territorial war. The first philosophy of a universal character will be the cosmopolitanism of the Stoic Zeno based on world human fraternity issued several centuries later, a brilliant idea at the base of humanism which the Christian Evangelists will seize to apply it to Catholicism.

Repression occurs when the ruling classes impose their selfish will on those they dominate to deprive, exploit and crush the weak. Thus the logic of domination was perpetuated. The first, the proletarians will be subject to work but free, the second subject to work but slaves supervised by warriors who ensure social cohesion and the defense of the territory and priests who ensure the spiritual tranquility of the soul in exchange for fidelity time in power. The despot man will continue his search for power through totalitarian barbarism towards others impure to his ethnicity: racism and slavery take shape as state policy.

By creating metaphysical Evil, Mesopotamian culture engendered a negative view of the world and of human nature. In Mesopotamia there appears the insane idea that the body is a prison where the soul that has sinned comes to redeem its fault. This vision based on the fall and the notion of fault inherent in being will emerge, throughout history, like a deadly shadow over all the civilizations of the region: we are thinking here of the Iranians, the Egyptians, the Jews, to the Arabs and will be at the origin of the Manichean Gnosticism which we will study later. Man becomes an impurity on earth and subjected to the most humiliating abjection. "I, the dog who blesses the king my lord and dares to approach you" are found in the writings of the time addressed to the despot king. This negative vision is really the crux of our human condition. The fear of the other, the sudden recognition of external danger, the anguish of man terrorized by the fear of famines and other natural calamities mean that we prefer humiliation if it brings security. This self-domestication of the species is inherent in human culture where life is ritualized, codified through a network of obligations and regulations whose functioning is ordered by religion.

Schelling said in The Ages of the World that "anguish is the fundamental feeling of every living creature. By diverting this "natural" anxiety into an artificially original fault, the Mesopotamian priests induced "fear before freedom and fear about freedom" so that the different kinds of neuroses no longer appear as more than hopeless forms of self-repression and self-destruction of human freedom. (Drewermann, Evil, 1996, p.41)

It must therefore be remembered that in ancient civilizations, man completely transformed his nomadic freedom into sedentary servitude where, ironically, tyrant and priest affirm to him that he is free in his servitude. And they are right because man has made a decision by which freedom is linked to itself, they are wrong when they think that this decision will last forever.

"Voluntary servitude" becomes a spontaneous decision by everyone in the face of common danger. But be careful up to a point, because if the internal conditions become worse than the external threats then the "rules of the game" no longer hold. A fundamental lesson of human history is that any community which resorts to the manipulation of its members to protect itself from annihilation becomes an instrument of terror which will inevitably be destroyed one day by revolt. And all of human history will be a slow but progressive emancipation from the constraints in force since Antiquity. The collapse of Soviet Communism is a recent example.

Evil exists only when opposed to good. The Mesopotamian despot succeeded in integrating in one person god/warrior-king/priest, the "holy trinity" of tyrannical power, the supreme guardian of the flock, "the lord of the royal pastoral art" of the first imperialist state which was a totalitarian theocratic, the dream still today of all Muslim, Jewish and Christian fundamentalists. (Sloterdijk, Rules for the Human Park 2000)

Theocracy is the political reign of the absolute Good, of Beauty, of Wisdom for the benefit of all, the man who revolts is nothing but impurity, ugliness and madness, this is the dogma that must be respected under penalty of to be banished from Paradise. "

Never has a State reached such a degree of opulence as manifested by the construction of the palace of Sargon which covers ten hectares dotted with sumptuous gardens and houses two hundred and nine rooms decorated with frescoes and bas-reliefs populated by a crowd of courtiers and priests. This titanic state power was, one can imagine, a tyranny managed administratively through an imposing bureaucracy and protected by an army never equaled in the ancient world. Enslavement became an essential component of progress, enrichment, conquest, power.

Having emptied man of his worth and belittled his beauty, the tyrant with the help of the clergy made the human masses into monsters in the service of the conquering gods. Thus man is forced to prove the necessity of his existence only by his productivity alone, so that life in common is weakened by mistrust and anxiety. The other becomes a curse and threatens my social position. As an economic competitor, the other risks depriving me of what I need to justify my existence. I must therefore annihilate him by liquidating his share of humanity, which will allow me later to use him as a beast of burden or to denigrate him as anti-human or non-human, fate which will be generally reserved for foreigners. Regardless of the type of society, the theme always remains the same: we use the other, we lower him, we degrade him, we insult him, we threaten him, we reject him, we torture him and finally we kill him. because we need it to justify our own existence and verify that we are indispensable to the community.

It is the "fall into evil" where in an ultimate attempt to end existential angst, he accelerates the process of the self-destruction of freedom itself. Suddenly, he realizes that the man is not what he should be, that his life is an aberration, an alienation dictated by fear. All the myths will tell in the form of a story the passage from purity to defilement and will try to explain the why of social prohibitions and their necessities as a regulating process of human destiny.

Despair is then experienced as a condemnation. Now that man has consented to compromise his freedom against the security of servitude, he knows at all times that he is responsible for his self-alienation. New anguish, because he knows that henceforth he is condemned to revolt, he is condemned to sin periodically so as not to sink into nothingness, hence the drama. Drama indeed, when the enslaved man is no longer ashamed of his condition, he prefers to definitively liquidate the freedom of his existence. Existential anguish is then replaced by despair, a state in which man has lost the courage to revolt. To despair of having to sin, such is the spiral of despair in which freedom and revolt are now frightening.

But why again, this original fault or negative philosophy of the bad man is so tenacious, why did it not die out at the same time as the Mesopotamian civilization?

Because the priests knew how to create an extraordinary bridge of communication by teaching writing and reading. Now it is obviously by the sacerdotal circles that these inventions were recovered, of course interpreted as signs of divine powers for the benefit of the equally divine king. Once again, all these constructions of human thought converge and "give their backing to state power, whose power is inscribed in parallel in the grandiose constructions of an art that exalts the supernatural for the benefit of despots and ruling strata, secular or clerical. (Lévesque, Beasts, Gods and Men 1985, p. 106)

The officiants celebrate the rites as a theatrical staging of a world in the making where men play a role that others have delivered before him, that others will deliver after him. Except that from now on, the piece will be written leaving little room for improvisation. The collective memory transmitted by an oral tradition accessible to all passes into the hands of learned men creating a new status and a specialized power.

For the first time, a clergy writes the religious history of a people where all the rites, rituals, songs, moralizing sermons are patiently codified and form the corpus of the first liturgies transmitted by writing. These liturgies are described in the Encyclopaedia Britannica thus: "They are arid hymns to the glory of the gods interspersed with pessimistic descriptions of human suffering describing the abject misery of life. Individualities are rarefied for the sole benefit of a community, a veritable mystical body, where the priests determine the unique codes of thought and precise rules of conduct.

But even more, the priest appropriated a power previously reserved for God, that of forgiving and above all saving man from his moral decay through rituals such as confession and ceremonies of repentance where the calamities that threaten men were averted.

By recovering the invention by traders of the alphabet and numbers, the priests have decreed that henceforth knowledge will be an essential component of power. It is no longer just a matter of directing and taming the already docile human herd, but above all of preventing the revolt of bellicose spirits through fear of banishment, of exile as a consequence of a fundamental opposition to "the ideology of the creator. Everything leads to making life meaningless, or rather, life as a whole appears as a punishment where work becomes the sole justification of existence and a curse since, whatever one does, human action is vain concern in the face of the death. All the founding writings of the Jewish Torah, the Bible, and the Koran were all thought out and produced in the area geographic region of the East and came under Mesopotamian influence.

This religious evolution was marked by the power struggle between the new castes of "urban" priests and the traditional shamans identified with the "religion of the hunt" or "religion of nature". While the caste of priests represented the current of general specialization of society in different trades, the shaman always confused him by his versatility, at the same time, magician, sorcerer, healer, soothsayer.

Since the Neolithic era, we have witnessed a real denial of the shaman intrinsically linked to nomadism. He is the master of changing practices adapted to places and types of frequentation. He acts alone, does not need a permanent temple but above all he has the power of direct contact with the spirits. He is the first to take the "mystical paths" to the afterlife, to establish the link between Heaven and Earth. Having become a religious rival, the shaman will

be opposed by all sedentary societies and doomed to contempt. Identified with the barbarian hordes, with backward peoples, he will be described as evil, possessed by evil spirits and affected by madness. Become suspect for the political power, the shamanism will be progressively proscribed and doomed to disappearance.

It is at this time that we notice the multiplication of magical practices and the development of occult disciplines, which will later become popular throughout the Asian and Mediterranean world. A parallel "religion" soon established itself and promoted these more "archaic" values. All this so-called occult world will perpetuate the magico-religious myths, rites and rituals of the Palaeolithic: reading of the viscera (oracles), the archaic bestiary integrated into the signs of the zodiac; the analogy between the mystical signs and the reality thus making it possible to control time and thus to know the future.

The passage from the archaic man of prehistory to the ancient man was therefore spread over several centuries. From this long evolution was born a whole panoply of concepts going from the economic exchange to the social organization while passing by a primitive technique centered mainly on the use of water, fire, earth.

This totality of powerful harmony has been expressed, for tens of millennia in man, by animism, the religion of the divine presence in all matter, plant, animal or being. It is the religion of fetish objects, of gods personalized by the totem. Until the day when the caste of shaman-priests replaced the peaceful multiplicity of individual totems with the great collective totem, the only reality. Thus, under the influence of the priests, the individual must subordinate his personal totem and attach himself to that of the group to the exclusion of all other fetishes.

The set of social relations symbolized by the Great Fetish of the tribe led the latter to completely reject the Great Fetish of the neighboring tribe, which the ethnologist De Brosses ironically translated in these terms: "there was no way that the Rat worshipers have long lived on good terms with cat worshipers. Hence the wars between fetishes exploited by the shamans of the different tribes. Beliefs become a source of fratricidal wars and appear at the same time as the notion of collective totem as a sign of identity for the first tribes. Yes, the Tribal God is downright warrior.

At first, the Sumerian cosmogony was represented by asexual gods having no definite personality who imitated the creative forces of nature; it is the world of primordial waters, a harmonious union of the animus and the anima where the god Enlil is "father and mother who creates himself. Thereafter, a typically terrestrial symbolism makes its entry; the celestial tree, the rock, sacred mountain, the sun and the moon. Later the gods took on half-human, half-animal forms: the lion, eagle, snake and above all the sacred bull. Everything indicates, thereafter, that this civilization is moving towards a theogony where the individuation of the gods is reflected in their human appearance. Bearded gods, long hair in a bun, they represent men of a superior humanity but living according to earthly customs. The king, representing the gods, shares with them the divine substance: the breath of life and the blood.

The gods of tradition are powers that attract and that we fear at the same time. It is therefore normal that the idea of power coincides with this power. But for this power to be embodied in power, it needs a precise ritual so that power in turn imposes itself as god. The chaotic, warlike and terrifying universe in which the Mesopotamians evolve commands the thirst for powerful gods whose power reverberates in their society.

"The gods are the strength that men would like to have: they are power itself and they respond to fear. Because of this, they are really powerful. Because these social creations do not depend on the vagaries of individual consciences. They are attested by the attachment of the group to its rituals and in fact, they are indeed there

for the desire and for the fear. Real powers, they are above all the indirect means thanks to which the desire for power can be assumed without too much anxiety. (Henri Hatzfeld, The Roots of Religion, 1993, p.192)

Subsequently, man gradually monopolized the animal images of the divine to the point of being its sole representative, as in Mesopotamia and Egypt. This passage from the divine animal representation to man, vicar of god, marks the beginnings of totalitarian states in the history of humanity. The vicissitudes of "real politic" kick off increasingly hegemonic practices. The gods of the conquered peoples must be enslaved to the new power in order to break any attempt at resistance by the local clergy. More and more appears in the cosmogony of the beginnings of history, a man despot depositary because king of the power of more and more dominant gods.

"The constitution of despotic states, with all the power relations it brings into play, is therefore accompanied by the constitution of a unified pantheon under the influence of dominating divinities and, moreover, this process in turn reinforces the power of the State with all the prestige of the fantastical. This unification is done in favor of gods with powerfully marked personalities who are like the projection into the fantasy of the despot and his family..." (Lévêque, Bêtes, dieux et hommes, 1985)

The cosmos therefore asserts itself as an ordered state around the figure of the king. (Jacobsen) This is how we witness a religious revolution in which the omnipotent god gradually appears, giving the despot king his hegemonic powers. All religious ritual is in the hands of priests where individual faith is absent. It is, in short, a religion without hope where the role of man is limited to serving the gods and the despot king through work. We can imagine despair as an artificial mutation of "natural" existential angst into alienation and neurosis imposed, provoked, from the outside. Nausea at the human condition becomes nausea at oneself and often revolt presents itself as the only way out other than suicide. The Empire is therefore constantly upset by series of popular uprisings often repressed by ruthless wars where "floods of blood were shed, cities razed, erased from the face of the earth. "

It was then that the Assyrian power was displayed in all its brutality which would make its reputation to this day, with a most modern army which combined infantry, war chariots, cavalry and siege machines.

The political universe of nation-states becomes invested with a religious mission of conquest of souls. Gradually a structure of domination of souls by vicars is set up, these "poisoners of life" propagating feelings of fear and guilt in the man whom they must enslave to totalitarian power : it is the birth of theocracy. And these ancient religions focused on the search for power and absolute power already contained the seed of their destruction:

"The wars of the city-states, for example in Mesopotamia, on the contrary, were very early aimed at the founding of empires by the long-term subjugation of other kingdoms based on cities. The logic of this evolution would later imply in this strategy of conquest even foreign and distant countries and peoples, the pretensions to power and greatness soon becoming an autonomous factor, without it being possible to see the end of this evolution. To tell the truth, precisely this excessive development of the aspiration to power often already contained the germ of ruin: after a certain time, the mastery of the occupied territories and of the submissive and always rebellious peoples absorbed too much energies, then lost for economic and cultural development. (E. Drewermann, Spiral of Fear, p. 47)

The Mesopotamian empire disintegrated, its language fell into "oblivion" like Latin and ancient Greek thereafter, only its writings survived until our days and influenced all the spiritual history of humanity . And let's not forget that in Mesopotamia, with the despot, was also born despair.

But before its disappearance, this pessimistic theology spread in Persia, today's Iran. Persian theology is at the junction of Indian and Mesopotamian theogonies. India and Iran shared the same gods for a long time. When the Aryan warriors settled in Iran, more precisely in ancient Persia, they erected fortified villages on the high plateaus and were introduced to a new concept, Mesopotamian royalty. Divine worship was rendered there both to the gods and to the king himself. Religion is therefore a political affair and complementary to the conquests which allowed the foundation of one of the greatest empires in history: the Median Empire, the "Empire of the Seven Seas" touching the Mediterranean, the Red Sea, Black Sea, Caspian Sea, Aral Sea, Arabian Sea and Persian Gulf.

The formation of an increasingly centralized political power requires a new religion that is just as strong and above all unequivocal. Came Zoroaster who amalgamated all the demons of the earth into a terrifying entity. Through the first Mesopotamian texts, the fault, the Evil according to commercial or warlike contacts, infiltrated the Iranian universe. Inspired by these, Zoroaster or Zarathustra undertook a great moral reform. Zoroaster - in Avestan Zaraoustra: "the camel driver" - is the founding prophet of Mazdaism (628-551 BC). He based his doctrine on the "good thought", the "good word" and the "good deed." Very quickly emerges a conviction of the universe based on the struggle between antagonisms, that is, the forces of good versus the forces of evil.

Around 600 BC, an event occurred that will upset the conception of the world in an irremediable way until today. It was there, in Iran, that the Magus founded the world's first dualistic religion (Mazdeism): an almighty God (Ahura-mazda), god, lord of Light opposed to a Devil (Ahriman), the destructive spirit of Darkness. Thus the mage Zarathustra embodied the Mesopotamian evil in a divine character: the Devil. Not only did he oppose the Devil to God but also damnation to salvation. This dualism will spread throughout Europe and will become the primordial axiom of Western civilization. Lucifer, Satan, Beelzebub, Asmodeus, Astaroth, Belial, Leviathan, Balberith, Mammon, Abaddon, Merihim, Nybas, etc., are all descendants of Ahriman.

"History is only the evolution of the idea of God in mankind. (Esquinos)

Parallel to the political message, a theological message is also essential. Thus the whole structure of human existence rests solely on what we would call "natural" anxiety. And the fundamental natural anxiety is strictly linked to the ambivalence of life and death: From prehistoric times, one must to consent to kill in order to live, to butcher and eat the animal or the plant that one venerates as a god with the consequence that one cannot survive without being guilty of this murder. What Cain's fratricide against Abel reminds us of.

The themes of the narrative such as sin and punishment, mortal hatred and shame, anguish and exile, the threat of peoples and confrontation, the submission of woman and the deification of man are themes upon which the history of mankind is built. To this, add the fear of hunger, poverty, disease and physical handicaps, fear of exclusion, of annihilation and finally of death and we have there the general topo of human distress dedicated to fear.

In 721 BC. AD, King Sargon II invaded the Kingdom of Israel. Using the pretext of a revolt, his son and successor, Sennacherib, deported the Hebrews from Israel between the Tigris and the Euphrates.
Nearly 4,000 years ago, with Abraham, was born Yahweh, the only god. In Yahweh, the man transposed there not the powerful harmony but the power of the hegemonic power as represented at the time by the Mesopotamian despot Sargon. In short, Yahweh is the Jewish response to Mesopotamian totalitarianism, its identical counterpart who alone freed the Jewish people from the tyranny of other nations. Allah is the Arab answer to the despot god of Jews and Christians and so on. The concept of God in monotheism is nothing other than a projection in favor of his clan of the fantasized power of hegemonic man.

"The absolute being, the god of man is his own essence. The power of the object over him is the power of his own essence. (...) What man... wishes to be, he makes it his God. (Feuerbach)

The arrival of monotheistic religions perpetuates the bond of subordination of man to God. Mesopotamia invented the fall, the fault, Iran, the devil, evil, to lower the individual, worse still, so that the individual himself justifies his subjugation. The common denominator being that all these "inventions" were made for political reasons. Each being the particular reflection of a political, royal, religious and aristocratic structure of an ancient empire.

All the foundations of the revealed monotheistic religions are therefore in place and it is Judaism which will be the first to welcome them into its midst and Christianity and Islam will follow. All monotheistic theologies have defended God to the detriment of man. Devaluation of the body, sexual drives, corporal punishment, brief complete annihilation of the "I". Michel Foucault, in Discipline and Punish, evokes a body conceived as a target of power, shaped by power so that it expresses the vision of the world desired by power.

History teaches us that the Hebrews endured exile and deportation to Babylon in Mesopotamian territory for several generations. Are we then surprised to discover all the Mesopotamian hatred towards man resurging at the source of Judaism in the Bible? The man, called the glebose, is associated with evil: seeing that the evil of the glebose multiplies, Yahveh (Yahweh) regrets having been the glebose on earth. "I will erase the glebe that I have created from the faces of the glebe. (Genesis VI; 6-7)

The march of history will now wander to the rhythm of oppression and submission between peoples. Except that from now on, Yahweh becomes the most formidable guarantee that man has ever given himself to justify the enslavement of peoples. Indeed, Dostoyevsky noted that the group is born of the conviction that it holds the absolute: its mores, its beliefs, its laws are the direct expression of this. Subsequently, every people is convinced that by realizing itself, it realizes God.

Thus, religion becomes the most formidable guarantor of the warlike strategy to realize the desire for domination of one people over another.

"Any people is a people only as long as it has its own god and excludes all other gods without any concession; as long as he has faith that he will conquer through his god and drive out all other gods from the world. (…) The people who lose this faith are no longer a people; but there is only one truth and therefore only one among the peoples can hold the true God, even though the others have their particular and great gods." (FM Dostoyevsky, The Possessed, The pocket book, Stock, 1949, p.260-261)

The trying exodus of the Israelite tribes towards the conquest of the land of Canaan is strewn for forty years of terrible wars until the final victory. Because the constant theme of the Old Testament is indeed that of the history of the genocides practiced by the Israelite tribes in the name of Yahweh. War is central to Hebrew theology; the defeats serve to punish Israel for its sins and the victories justify the final destiny of the chosen people, which is to subordinate all nations to the law of Yahweh.

Committing genocide, in the Old Testament, is called "devoting oneself to the forbidden". Here are a few eloquent examples. Let's start with Deuteronomy attributed to Moses.

"the Lord our God has delivered Og and all his people (...) we have condemned them to the ban (...) the men, the women, the children" (Dt 3, 3-6)

"And now Israel, listen to the laws and customs that I myself teach you to put into practice... You have seen with your eyes what the Lord did in Baal-Peor: all those who followed the Baal of Peor , the Lord, your God has destroyed them "(Dt 4, 1 and 3)

"Listen, Israel! Today you are going to cross the Jordan to dispossess nations greater than you. . . . You will dispossess them and immediately destroy them." (Dt 9, 1-4)

"But the cities of these tribes, which the Lord your God gives you as an inheritance, are the only ones where you will not allow any living being to remain. Indeed, you will devote totally to the prohibition the Hititte, the Amorite, the Canaanite, the Perizite, the Hivvite and the Jebusite, as the Lord your God has commanded you. (Dt 20, 10-7)

"When the Lord your God brings you into the land which you have just taken possession of and drives out many nations before you . . . seven nations more numerous and stronger than you. When the Lord your God has delivered them to you and you have defeated them, you will condemn them completely to the ban. You will not make a covenant with them, you will not be gracious to them. You will not enter into marriage with them, you will not give your daughter to their son, you will not take their daughter for your son." (Dt 7, 2-4)

And Joshua, the successor of Moses, pursues this policy of genocide and racist marriage legislation with the same religious zeal. First, the Jericho massacre:

"They condemned everything that was in the city to the ban, both man and woman, young man and old man...putting them all to the sword." (Josh 6.21)

And the litany of massacres continues: "Joshua burned Ai and turned it into ruins forever." (Jos 8,28), the extermination of the people of Maqqeda (Jos 10,20), the city of Lachish where Joshua "leaves no survivors" (Jos 10, 34), that of Hebron "where he leaves no survivor as he had treated Eglon" (10, 37), "he treated Devir as he had treated Hebron" (10, 39), "He left no survivor..., he condemned all living beings to the ban" (10, 39 and 40), "no survivors" (11, 8) for the Amotites, the Canaanites, the Prizzites, the Jebusites. (Garaudy, Towards a religious war?, 1995)

Theological domination now explains the political forms of violence that eventually lead to holy wars organized. veritable genocides considered today as crimes against humanity. Now that war intervenes as a political method, the door is therefore wide open to welcome the heroic king by the grace of God and immediately closes it in the face of the enemy brother.

The massacre of the pagans, their deportation, the confiscation of their goods were simply aimed at establishing the hegemony of Christianity over the Empire and thus accomplishing revenge for past humiliations. All this demonstrates, once again and this from Mesopotamia via Iran and Palestine, that the political despotism inherent in religious concepts seriously contaminated the nascent European Christianity. This contamination, this search for the temporal powers that are wealth and hegemonic power will give birth, a true betrayal of the Christic message, to the theology of universal domination as a system of total Unity. The policy of the Popes, those of modern times as well as those of the Middle Ages, has always been to oppose the constitution of a kingdom competing with the Church.

It is the same in the Quran. In sura XIV of the Koran entitled Abraham, it is written that a prophet from the people of Mecca must come to purify the Sacred House of pagan worship. Imitating Jewish zealots and Christian monks, Muhammad orders holy war ("The religion that wins wars conquers souls") against all infidels, rebels and their idols. To protect himself from persecution, Muhammad undertook the Hegira and the conquest of Mecca.

Imitating the Yahweh of the Jews, a cruel god who orders Joshua to condemn his enemies to prohibition, Muhammad, in the sura of repentance (9), orders that all the infidels be put to the sword and also condemned to prohibited.

"After the sacred months have passed, kill the Infidels, wherever they are! Take them! Besiege them! Set up ambushes for them! " (verse 5)

A little further on in the same Sura of Repentance, Muhammad repeats word for word the same threat from Yahweh to the Hebrew people if he deviates from him:

"If you do not march to battle, Allah will punish you with a painful chastisement; he will replace you with another people, and you will not be able to harm him in any way. Allah is almighty. " (sura 9, verse 39)

The Muslim cycle of massacres and genocides where "blood flowed like rivers" includes three great conquests, that of Arabia, the conquest of Mesopotamia (Iraq) and that of Syria-Palestine, culminating in the capture of Medina and Mecca, the capture of Baghdad and Damascus and the capture of Jerusalem.

Since Mesopotamia, therefore, a succession of ruthless gods has been perpetuated who want to govern the world by instituting a religion of Terror supported by prophets, rabbis, priests, imams, faithful warriors and barbarians. All monotheisms and their theocracy are totalitarian in essence.

The cosmic fall of souls on earth according to the Mesopotamian astrologers became in Genesis the fall of man, of Adam and Eve, into original sin. Even more, the fall of man drags with it all nature. In all the biblical religions (Judaism, Christianity, Islam), the earth is a prison from which one must escape. Added to the curse that strikes man in Genesis is that of the land where he was born:

"…cursed be the ground for your sake! By dint of pain, you will derive sustenance from it all the days of your life. He will produce thorns and thistles for you and you will eat the grass of the field…" (Gn 3, 17-19)

Salvation cannot come on this accursed land. NASA images, showing us our beautiful bright blue planet on backdrop of icy darkness of the sidereal "vacuum", makes it clear that ultimately there will be no escapes from the adverse consequences of human action on the looming environmental crisis. We no longer have the time despite the beautiful utopians of the technosciences; human activity has weakened the biosphere too much and highlights the impotence and lack of courage of the international community.

The current environmental crisis being a reflection of the spiritual crisis of denatured man.

"All my methods, all my means are sensible; it's my goal that's crazy. (Melville)

These words of Captain Ahab in Moby Dick reflect all the proud animosity of man and the almost satanic technical means that are implemented to bring nature (the white whale) to heel.

"Obviously mankind continues to devote itself to the sinister hunt described by Melville, drawn by adventure, the prospect of oil and whales, the promptings of pride, and above all by a pursuit of power which reject love. She also began to consciously contemplate the prospect of total annihilation that might be wrought by today's captains at the helm of the ship. (Mumford, The Myth of the Machine, T.II, 1974, p.511)

Western civilization is centered on the enslavement of nature and the control of the body, both physical and social, thanks to science supported by political and religious power.

aFrom the beauty, the "wisdom", the majesty of living beings, animals and plants, we have retained only their food and domestic utility and have abandoned them to the lamentable fate to which we have forced them. The biblical command that man care for all of God's creation has not been followed. The classification into clean and unclean animals, an endless list of dietary precepts and a series of decrees including the prohibition of sodomy with animals, this is the context in which a monotheistic theologian learns about animals in the Old Testament. As for nature in general:

"Submit it; rule over the fish of the sea, the birds of the sky and all the animals that crawl on the earth. (Genesis I, 28)

With regard to animals in particular:

"Do not make yourselves filthy with all these swarming creatures, do not contaminate yourselves with them and do not be contaminated by them. For I, Yahweh, am your God. You have sanctified yourselves and you have become holy because I am holy; don't make yourselves unclean with all these bugs that crawl on the earth. (Lev 11:43-44)

Moreover, Yahweh, God and Allah entrusted the world with all its creatures to man to fulfill His commandments by ruling it. Thereafter, nature completely disappeared as a mythical reference in the desert of monotheistic religions.

"It was the prophets, the apostles and their successors, the missionaries, who convinced the Western world that a stone (considered sacred by some) was only a stone, that planets and stars were only cosmic objects; in other words, that they are (and cannot be) neither gods, nor angels, nor demons. It is following this long process of desacralization of Nature that Westerners succeeded in seeing a natural object, where their ancestors saw theophanies, sacred presences. (Eliade)

"The current environmental crisis is essentially spiritual. From both a historical and a practical point of view, it is not possible to approach it without reference to religion and ethics. The American historian Lynn White rightly attributed the causes of the problem to Christian theology, especially the Western church which exploited the verses of Genesis containing the order given by God to the first human beings to "dominate the Earth" so as to encourage them, as Descartes put it bluntly, to be the "masters and possessors of Nature" This attitude was again inspired by a theology which underlined the superiority of humans because of their "logic" considered as "the image of God" in man. This rationalist approach made human beings stand out from the rest of Creation and encouraged them to regard with contempt all that is neither rational nor human." (Metropolitan Jean de Pergamon, Ecological Asceticism, 1995)

On the other hand, as several exegetes note, Christianity put an end to animal sacrifices, rituals practiced since the dawn of time and endorsed by Judaism. As Saint Augustine points out, "the divine has no use for cattle" since the son of God himself sacrificed himself on the cross. The abandonment of animal sacrifices did not, however, put an end to their exploitation throughout the world.

Five hundred years ago, we gave birth to an economic machine which, like an ogre, will eat up all available resources until supplies run out. The notion of chosen people was transformed into a chosen species: only man is holy and this anthropocentric notion will have inestimable consequences on our relationship with the environment and on other animal or plant species. Continuing on his momentum, Descartes then proposes the thesis according to which it is impossible to find a difference between the animal and the machine. Spinoza, on the other hand, declared that humans are entitled "to use animals as we please and to treat them according to what suits us best since they do not agree with us by nature and their feelings are, by nature, different from human feelings. "

Finally, the philosopher Fichte completed the picture and asserted in his Doctrine of Natural Law in 1796, that all domestic animals are "under the guardianship" of man for "regular use" and are only "property". . As for wild animals, they are "harmful" and "considered an enemy". This is how what in the West has been formulated as a commonplace: anthropocentrism does not recognize the right of creatures, it only knows men and their needs.

The exultation of war

Let's take a time leap several centuries and here we are before the Manifesto of the Italian Futurism movement at the beginning of the 20th century which exults the law of the strongest in these terms:

7- There is no more beauty than in the fight. No masterpiece without an aggressive character. Poetry must be a violent assault against unknown forces, to summon them to lie down before man.

8- We are on the extreme promontory of the centuries!… What is the use of looking behind us, as long as we have to break down the mysterious doors of the impossible? Time and space died yesterday. We already live in the absolute, since we have already created the eternal omnipresent speed.

9- We want to glorify war - the only hygiene in the world -, militarism, patriotism, the destructive gesture of anarchists, beautiful ideas that kill and... contempt for women...

10- We want to demolish museums, libraries, fight moralism, feminism and all opportunistic and utilitarian cowardice.

11- We will sing the great crowds agitated by work, pleasure or revolt: the multicolored and polyphonic undertows of revolutions in modern capitals; the nocturnal vibration of the arsenals and shipyards under their violent electric moons; them gluttonous stations swallowing smoking snakes; the factories suspended from the clouds by the strings of their smoke; the jumping bridges of gymnasts launched on the diabolical cutlery of sunny rivers; the adventurous liners sniffing the horizon; the big-breasted locomotives prancing along the rails like huge steel horses strapped to long pipes, and the gliding flight of aeroplanes, whose propellers flapping flags and cheering crowds.

Destroy, deconstruct, put an end to the backward-looking order of ruins and decadent museums; even the present has value only because it is an obligatory passage to reach the goal. New century, new technique, new civilization, new city, social novelty of the urban masses, for the first time, the mechanical order becomes ideology of the "new Jerusalem".

The Futurists have been the most tenacious supporters of "war until final victory" and imperialism. They never ceased to exalt war, that war constituted the only hygienic remedy for the universe.

Participating in the Futurist movement were monarchists, communists, republicans and fascists who formulated or sought to formulate the theories that Machiavelli preached to 15th century Italy: namely, that the struggle which divides local parties and leads the nation into chaos can only be buried by an absolute monarch, a new Caesar Borgia who would place himself at the head of the rival parties. We already feel Mussolini dawning on the horizon.

The main spokesmen of pre-war futurism became fascists. These artists join an entire generation of individuals who believe they recognize in fascism a movement as revolutionary as communism; a third possible way between capitalism and Marxism by giving hope to a takeover of production by the workers themselves in a market economy. Italian fascism begets Soviet communism and German nazism which will lead humanity towards the second world war.

In The Descent of Man, then in a sequel, The Expression of Emotions in Man and Animals (1872), Darwin pushed evolutionary logic very far. He thus lays the theoretical foundations of what has been called "social Darwinism", "according to which human society is governed by the same laws of selection as the rest of nature and, in particular, as commercial competition, colonialism, and the extermination of certain "races" only reflect the "natural" triumph of the strongest over the weakest. "

The main representative of social Darwinism is the Englishman Herbert Spencer (1820-1903)

"Social Darwinism affirms that competition, the struggle for life, affects, within the human species, the different social groups that compose it (family, ethnic, state) in such a way that hierarchies are created, which are the result of a social selection that allows the best to win. However, for Spencer, all social groups being in competition with each other, everything that can weaken a social group benefits its competitors.

Consequently, Spencer thinks that any artificial protection of the weak is a handicap for the social group to which they belong, insofar as this protection has the effect of weighing down the functioning of the group and, therefore, of putting it in a position of inferiority. in the face of rival social groups." (Denis Touret)

"The greatest progress of modern civilization is to have produced beings capable of supporting it. "

It is the whole ideology of the cicada and the ant which is put in square. Spencer shares a liberal, anti-statist conception of the economy. He is hostile to poverty laws, to public education, to public health, to family protections. As a general rule, this theory is opposed by the powerful, to the egalitarian or social democratic wills of the middle class and the excluded. It can serve as a support for both liberal and especially ultra-liberal theories as well as conservative or totalitarian theories. Social Darwinism will become an inescapable component of Italian Fascism and German Nazism.

The human predisposition to aggression is particularly marked in young men, no doubt for partly hormonal reasons. This explains why we observe a strong correlation between the existence of certain demographic structures and the propensity for armed conflict.

Mussolini recruited among the soldiers, the students, the young workers and the unemployed the members of the fascist brigades. All over Europe a huge cohort of citizens frustrated in their desire for heroic exploits asked only to serve a noble cause. Mussolini's Fascist Black Shirts, Hitler's Nazi Brown Shirts, General Franco's Spanish Phalanges, Hungary's Arrow Cross, Rumania's Iron Guards fulfilled their unfulfilled desire. All these ultra-nationalist movements prophesied on the ruins of the first war the mythical advent of a decisive victory over the forces of evil and disorder. Because the fascist elite requires noble qualities present in all classes of society. It is the mental predispositions, strengths of character and leadership that prevail over basely socio-economic considerations. Any being who feels capable of governing society can be part of this elite by virtue of the law of natural selection.

With the firm belief that Darwinian evolution was true, Hitler saw himself as the modern savior of mankind. Here it is genetics that functions as the Gospel, it is the tragic recovery of the religious by science for the benefit of a messianic project:

"If there is a divine command that I can accept, it is this: 'Thou shalt preserve the species.' " (Hitler)

Hitler believed that humans were animals for which the laws of genetics observed in cattle breeding could be applied, thus he joined the Nietzschean vision of the superman. Hitler was certain that the "bad blood" of the lower races was contaminating the Aryan race.

"Hitler was influenced above all by the theories of social Darwinism of the nineteenth century, whose conception of man as biological matter was directed by his impulses towards an organized society. He was convinced that the race was disintegrating and deteriorating because of bad marriages resulting from promiscuity tinged with liberality that stained the blood of the nation. And this led to the establishment of a catalog of 'positive' curative measures: racial hygiene, eugenic mate choice, the breeding of human beings by methods of selection on the one hand and extirpation the other. "Hitler's efforts to put members of these lower races into concentration camps stemmed less from a desire to punish than from a desire to protect the wholesome community, as it is customary to quarantine sick people. According to Haas, the Nazis believed that "killing Jews and others was actually a scientific and rational way to serve a higher purpose. (Jerry Bergman, Darwinism and the Nazi Holocaust, http://www.trueorigin.org/holocaust.asp)

The Rape of Nanjing

"The Rape of Nanjing" perpetrated by Japanese soldiers against the civilian population with supporting testimony; massacre that Japan refuses to recognize. And for good reason ! Historians believe it was the most heinous massacre of the 20th century: hundreds of thousands (+ 300,000) murders and summary executions at gunpoint and bayonet and tens of thousands of rapes and sodomy including on corpses. Like an epitaph, the words printed in Chinese characters on the business card, mistranslated into English below, sum up the old lady's entire existence: "Li Xiuying. Survivor of the Nanking massacre during the invasion in China" in 1937. At the age of 78, Mrs. Li came from Nanjing, capital of Jiangsu province, which she had never left, to Canada to bear witness to the atrocities committed by the Imperial Japanese army in China. , more than half a century ago. A dark period in Japanese history that many Japanese often ignore, or pretend to ignore, when they do not simply dispute the reality of this past. Many Japanese also deny that the imperial army enlisted tens of thousands of "sex slaves", a fact long established by historians. "Some Japanese still say that there has never been a massacre in Nanjing, it's unbearable. To those, I reply by showing them my arms and my legs, my face; "I am the proof alive".

Here is the verbatim of the documentary presented which is dedicated to him 140,000 to 300,000 dead. Nanjing, then the capital of China, fell in December 1937, a few months after the start of the invasion of China by the Imperial Japanese army. An occupation that lasted until the surrender of Japan in August 1945. According to the Tokyo war crimes trials, which took place after the conflict, more than 140,000 Chinese civilians and prisoners of war were executed by Japanese forces for six weeks after the fall of the city. Some Chinese historians even speak of 300,000 dead. Figures obviously disputed on the Japanese side. Head bowed, comfortable in her old gray suit, she recounts that morning of December 19, 1937, when Japanese soldiers burst into the shelter where she had been hiding for several days with 70 other people.

"These shelters had been set up by foreign embassies. We were about forty women, most were very young. The men took care of the supplies and often went out, because there was no water at inside. We thought we were safe." The narrative is almost mechanical. Then over the course of the conversation, the old lady becomes agitated, seems to relive the sufferings that come back. "The Japanese took the men away first. Later they came back. We knew they were going to rape us." Seven months pregnant, Li, then 19, wanted to kill herself. She mimes: "I banged my head against the stone wall and ended up fainting." 37 stab wounds. Left for dead, young Li survived it for the first time. But again, soldiers came in the afternoon. "There were three of them. One of them led the others out and immediately rushed at me to rip my clothes off. My sweater was very tight." A modest smile slips on her face, at the mention of the young girl she was. Then she straightens up. "So, with all my rage, I am beaten.

I bit him, scratched his face, he was bleeding. I even managed to take his knife from him. But the other two ended up coming to her rescue." And then the horror. "They beat me with a knife. I received 37 blade strikes. First to the legs." She points to her legs. "Then to the face. All over her face." So she takes your hand to feel her cheeks. She knows that the wrinkles have now almost covered the scars of her ordeal. She won't say if the soldiers abused her. Madame Li is one of the only survivors still able to testify. Along with nine other of her fellow citizens, victims of horrific abuse, she began a legal action in August 1995, the date of the celebration of the fiftieth anniversary of the end of the war. She survived thanks to the care provided by an American pastor, but lost her child.Pastor Maggee, who saved several survivors by hiding them in his church, had the idea of filming the victims.Ms Li stayed for two months in the hospital. "I was totally disfigured. For a very long time, I refused to leave my house." Because of her face, she was never able to work. And her family suffered from this lack of money. "I could not offer my children a good education." This is the biggest regret of his life. ""People looked at me strangely, like an abnormal or crazy person." She's searching. "Like I'm a ghost. That's it." Still, young Li was pretty, very pretty. She says it, her eyes squinting with the hope that someone can believe her. And finally let go: "That's what people said at the time"..

Nuclear horror

On August 6 and 9, 1945, the Japanese cities of Hiroshima and Nagasaki were literally "returned to the Stone Age", the favorite expression of then Air Force boss General Curtis Le May. Throughout his presidency, Harry Truman claimed that the destruction of Hiroshima and Nagasaki had saved a quarter of a million human lives. And yet, even General Dwight Eisenhower informed his superiors "that Japan was already defeated, its reissue was only a matter of days, and the use of the bomb was completely unnecessary." So why the Japanese holocaust ? Response in Chronicle of the Second World War, page 606:

"One may wonder, after this murderous raid, why a historic city without any military interest was devastated in this way. The Americans, in particular - although they participated fully - have considered "terrorist. "But above all, why a second atomic bomb, that of Nagasaki, when Japan was already "knocked out" by that of Hiroshima? Dresden (400,000 dead), Hiroshima (140,000) and Nagasaki (80,000) n he were, in fact, only guinea pig cities whose destruction aimed to impress the Soviets militarily and marked "unofficially" the beginning of the Cold War: a strategy of terror concocted by the Churchill-Truman tandem. This powerful explosive completely changed the diplomatic balance in favor of the allies. It therefore remained to demonstrate to the Russians that we had the logistical capabilities to use it. Unthinkable for the allies, the perspective of a typically anthropocentric, economically communist and atheistic millenarianism geopolitically universalist without any transcendental dimension, in short, which rejects the religion of God in favor of the religion of the State.

Hiroshima and Nagasaki were the cities designated to make the demonstration. dramatic version of modern terror. As a demonic scenario, even the gods have never done better. Homo sapiens or Homo demens, "that's the question! " Sparkling debris stretch out in a vast landscape clear ashes which are these burnt bodies with raw flesh Strange rhythm of the bodies of dead men Did all this exist? Tamiki Hara These images of Hiroshima were confiscated for fourteen years by the American authorities and revealed to the world in the film Hiroshima mon amour (1959) by Alain Resnais. At the beginning of the film, sick, irradiated, silent Japanese women look at us quietly to better guide our gaze towards these unbearable images. Before these terrible photos, there were only oral and written testimonies. The testimony below, comes from the Japanese military doctor Shuntaro Hida, in "Little boy" -

Tales of Hiroshima Days.

"I was going down the slope at full speed, when a figure appeared around the bend. Was it still a human being? He approached me, staggering. He was naked, bleeding, covered in mud, his body swollen. rags of torn clothes hung on his chest and around his waist. He held his hands in front of his chest, palms down. Drops of water were falling from the edges of his rags. But when he was close to me, I saw that the shreds of fabric were none other than his skin and the drops of water of human blood. I could not distinguish whether I had before me a man or a woman, a soldier or a civilian. The head was singularly large, with puffy eyelids and thick protruding lips that seemed to take up half of the face. There was not a single hair left on the burned skull. I couldn't help but step back. Then I saw a procession of other figures slowly climbing towards me along the road. I had no medicine or instructions. lie with me. I was distraught. It was impossible for me to make my way between these unfortunates. I jumped into the river without hesitation. I hurried down the course of the river, under the luxuriant vegetation which grows along the banks in summer. Driven by a violent wind, clouds of smoke swirled on the surface of the water. The hot breath slapped my face, the hot smoke suffocated me. Noting that under my feet the rocks of the bed of the river had given way to sand, I realized that I had finally reached Choju-En, one of the great parks on the outskirts of Hiroshima. I sank into a storm of deep red flames. The blue of the summer sky was gone. Around me, under the black wind , the river was reddened by the reflection of the flames. As soon as the heat became intolerable, I plunged my face into the water while holding my breath. In the park, the Ohta River is divided into two arms, one leading straight to Hiroshima Bay, the other, the Kanda River, heading east. To reach the city, the Hesaka road crosses the Kanda River on a suspension bridge.

When he reached me, he jumped into the water and said to me: "Doctor, go back to Hesaka right away! There are a multitude of wounded people. They are waiting for you." I immediately understood the situation. He shook my hand, promised to inquire about the fate of the military hospital, then he disappeared into the mist with his soldiers. "Beginning of a tragedy. (…) "I believe that it was at least a week after the bombardment that the first symptoms appeared among the survivors who had taken refuge in Hesaka. However, it may very well be that some strange phenomena have happened before. Given the number of deaths counted each day, a sudden evolution of symptoms could well have escaped us. And this, all the better since, in the first days, signs of improvement had appeared in the major burn victims. We had begun to hope that victims with relatively shallow wounds would recover more quickly than their general condition and the frightening appearance of their sore-covered bodies would have predicted. (…) Swarms of flies covered the wounds of the wounded who could not move. Big white maggots swarmed around their eyes, their ears, their nose. It may seem strange, but we were helped in our task by these big white maggots which cleaned the gangrenous skin of our patients by ridding it of all necrotic tissue!

It was with the report of one of our nurses that the strange "epidemic" began for us which was to preoccupy us night and day for so long. According to this report, some patients had just undergone a bout of fever which had exceeded 40° C. We rushed to the bedside of these patients to examine them. They were dripping with sweat and their tonsils were starting to break down. While we were confounded by the severity and violence of the symptoms, more and more bleeding appeared in the mucous membranes. Soon, the patients began to cough up large amounts of blood. Despite resorting to emergency blood transfusions and applications of Ringer's solutions, we were unable to stem what then appeared to us to be an epidemic.

The number of victims of these sudden and violent haemorrhages increased from hour to hour. In fact, the medical staff thought they were dealing with an epidemic of typhoid fever or dysentery. Of course, we used a treatment based on coagulants and haemostatics, but this had no other effect than to relieve our conscience. At the same time, another "epidemic" descended on the survivors.

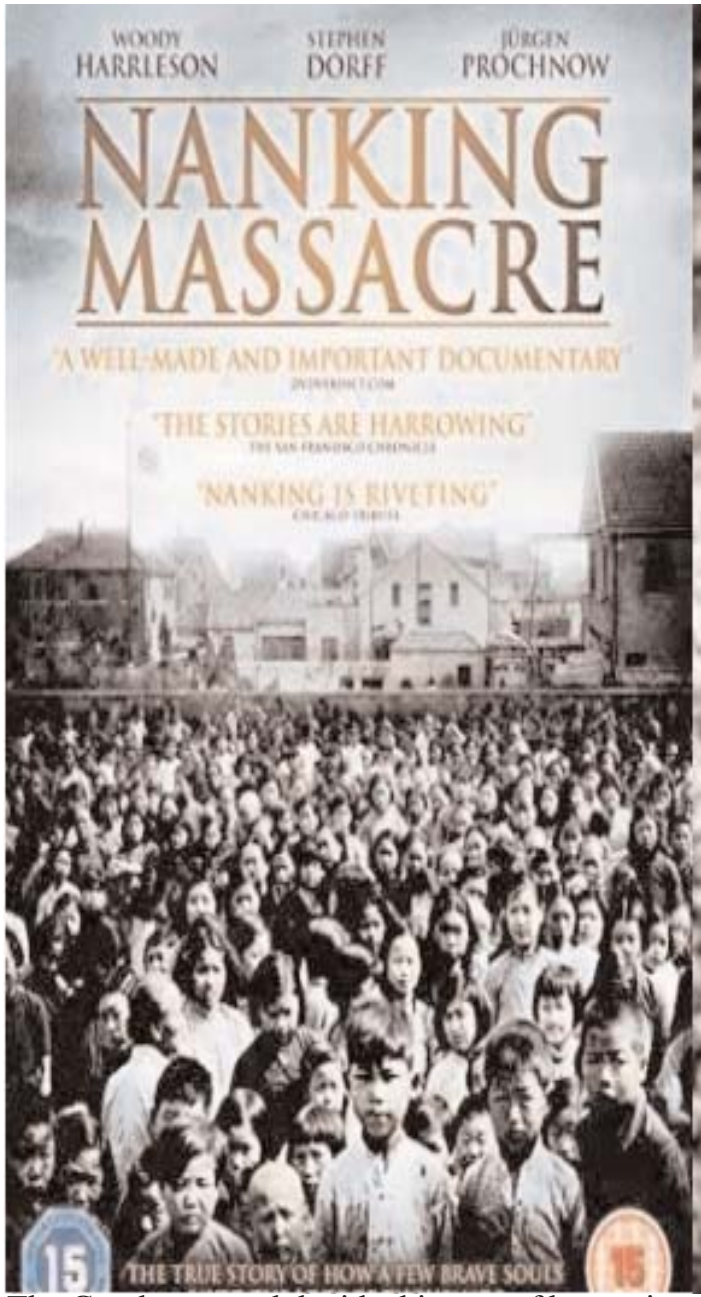
They called it "encounter." been shaved. The unfortunates who presented these symptoms (fever, pain in the throat, bleeding, hair loss) found themselves in less than an hour in a completely critical state. Despite our best efforts, only a few gave us the impression that we could escape death. As the hours passed, the survivors fell ill in groups of seven or eight, then they died around the same time. Later, I understood that those who died together had been, at the moment of the explosion, at an equal distance from its epicentre. Meaning they had received a substantially similar dose of radiation. In fact, these men and women who died in successive series confirmed the laws which govern nuclear physics, as simple experimentally irradiated guinea pigs would have done. But, in the early days, we did not know the real cause of the "epidemic." Since the Japanese army headquarters had never mentioned the possibility of an atomic bombing, we still believed that it was was the explosion of a new type of classic but extremely powerful bomb. Since the majority of patients presented similar symptoms (intestinal bleeding), we honestly thought we were dealing with cases of dysentery.

But under the authority of the head doctor, we proceeded at night and in the greatest secrecy with the autopsy of the bodies of patients who had died during the day. The corpses piled up in a field near the village before being cremated. We placed them on a metal plate and made an incision in the abdomen with a sharp knife. One of the objectives of these autopsies was to verify whether the cause of the intestinal bleeding was of inflammatory origin or not. I carefully examined the mucous samples by candlelight. I discovered none of the characteristic signs of dysentery. A few days later, when we learned of the information that the Imperial Navy radio station in Kure had picked up a broadcast from American radio stating that an atomic bomb had been used in Hiroshima, we considered problem in a different light.

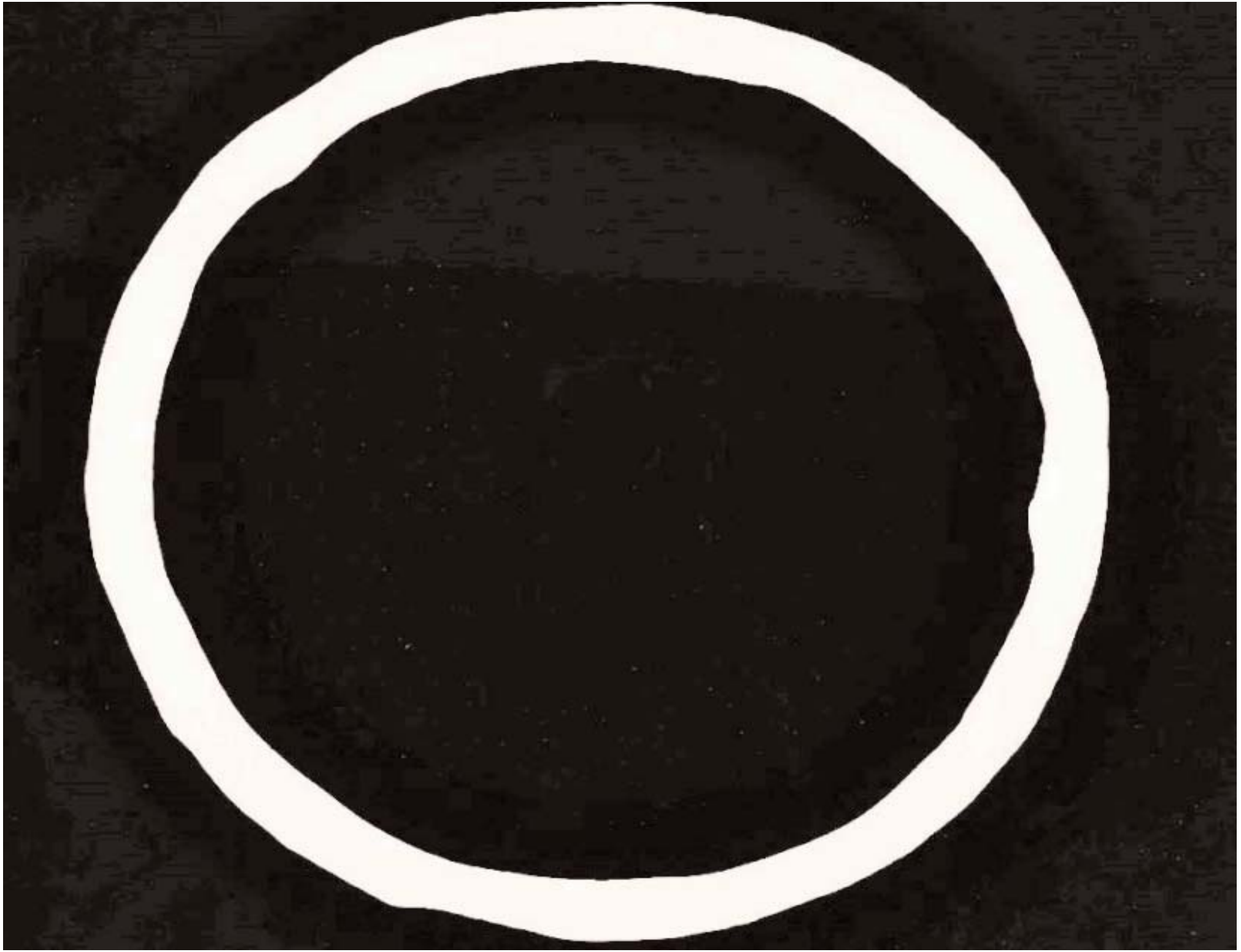
The syndrome that we had been unable to clearly define could now be explained by exposure to radiation leading to a disruption of the blood system. But, even if we had known this earlier, we would have been just as powerless to stop an evil against which there was no effective treatment. Someone suggested resorting to the application of persimmon leaves, as they are rich in vitamins. The leaves were collected and used by many survivors convinced of their beneficial effects. Most doctors laughed it off, claiming it was all superstition. In truth, this treatment based on persimmon leaves proved positive for many patients. This was certainly not the only phenomenon to remain unexplained. At the time, we were unable to understand the nature of the evil that overwhelmed the survivors. (…) We didn't know then what the residual radiation was." Exhibition "off" - Japan exploded. The "atomic" depression strongly marked the post-war intellectual climate. Since then, modern Western man has lived in the anguish and finds himself in a state close to agony.Of course the man knew he was mortal but suddenly he discovers with dismay that his civilization risks dying, disappearing before his eyes by his own irresponsibility.

The foundations of his existence are shaken, he feels lost in a chaotic world. He lost his inner balance. Man finds himself faced with a new reality for which he is ill-prepared spiritually. If we situate Nietzsche's statement on the death of God around 1880 and the Holocaust and Hiroshima in the mid-1940s, it will have taken less than a century for the new world without God, created by human hands, to sink into his turn in barbarism without ever emerging from the atrocities of war. We know the joke: "God is dead, man is sick and I myself don't feel very well." So in all aspects of life, man will always have chosen thanatos. Seduction of disaster? Never had the instinct of death manifested itself so ferociously on civilian populations.

été. Poussés par un vent violent, des nuages de fumée tourbillonnaient à la surface de l'eau. Le souffle brûlant me giflait le visage, la fumée chaude me suffoquait. En constatant que sous mes pieds les rochers du lit de la rivière avaient fait place à du sable, je compris que j'avais enfin atteint le Choju-En, un des grands parcs de la périphérie d'Hiroshima. Je m'enfonçais dans une tempête de flammes d'un rouge profond. Le bleu du ciel d'été avait disparu. Autour de moi, sous le



The Greeks created the ideal image of humanity and democracy while treating slaves cruelly. The 20th century became acquainted with typically human totalitarian ideologies (Hitler, Stalin, Hiro Hito, Mao) without the pretext of a vengeful god. The philosophy of the Enlightenment did not prevent Nanjing, Auschwitz and Hiroshima. Now the problem is more extreme. Globalization creates a planetary ghetto with its own inner truth by locking the whole world into a techno-economy that totally isolates the individual. And so, everything will continue until its apotheosis: the world will turn into an immense virtual delirium. Our era is not post-modern, but posthumous. Besides, here is the black sunset.



Towards the Capitalocene

It is characteristic to note that all messianic movements are based on a purification of society. Hitlerism, Stalinism and Maoism are no exception to the rule in their mission to erase all the social faults of the past and to engender a new man. As if the whole apparatus of life were becoming a megacomplex of production, distribution, consumption so specialized and so subdivided that the individual no longer finds his way around, lost in the labyrinth of his own life, at the mercy of forces that they no longer control, heading in a direction he does not know. The Era of the masses has just been born.

From now on, individual salvation passes through social status; having replacing being. The abstraction of the beyond as an existential finality with the sacrifices and the renunciations that it imposes to reach it is evacuated in favor of a more pragmatic and earthly finality: materialism as the accomplishment of being on Earth. The businessman, the industrialist, the financier are its evangelists. By contagion, materialism spread at the speed of a pandemic in all social strata. Only the elite, the best, will have access to the Eden of success. Access to materialistic Eden passes of course by the appropriation of the goods of the earth and will have as a consequence a very significant fact which increased still more the social division: accession to Eden is transmissible by inheritance. One can inherit Heaven on Earth by blood ties, from man to man. "The hominization of nature" (anthropocentrism) associated with the "law of the strongest" become the foundations of both the modern theology of the man-god and of capitalism.

Welcome to the world of liberal capitalism.

"I am a little nonno in front of the economic thing and certain helpful readers sometimes undertake to redo my education. Every 50 years, therefore explains to me (a reader), liberal economies "cleanse" themselves of accumulated exaggerations (especially because of the unions), excessive salaries, social advantages, etc. This is called an economic depression. My professor adds, that certainly, these economic depressions are the occasion for the sharks of the system to manifest themselves, but it is normal and we waste our time blaming the sharks for being wild animals. It is not in the order of things that the gazelles ask the big cats to eat grass, underlines Mr. Michaud. You are bright, sir. I finally understood what a liberal economy was So here it is. if I sum up for you, there are big cats and there are gazelles. Wild animals eat gazelle. Gazelles eat grass, as long as there is any. When there are no more (if they were less greedy too!), when there are no more (economic depression) they eat shit. Which doesn't bother the big cats too much, as they continue to eat gazelle. And then one day, everything works out, the grass ends up growing back (Inflation), the gazelles are happy and the big cats too because the gazelles taste much better when they eat grass than when they eat shit. Is that a liberal economy? (Pierre Foglia)

So here we are in mediocracy where when the politician adopts the mentality of the golden boy of Wall Street twinned with that of the conspirator, this translates when the private interest prevails over the public interest, by the following situation: The money of the American elections comes from the wealthiest donors, people often with very different priorities than the majority of Americans. In fact, one-fifth of all super PAC donations over the past 10 years have come from just 11 people. This led to a dysfunctional oligarchic government under the guise of democracy.

Here is a country, the USA where, for twenty years, political antagonisms have crystallized to the point that one half of the country hates the other, no longer speaks to it, does not even understand it, even denies its right to exist.

A country where the Senate and the House of Representatives combined can hardly vote anything, due to permanent deadlock. A country where the division of powers is crumbling, where the Court supreme is increasingly making its decisions along partisan lines. A country where university campuses are entrenched camps, where the so-called "humanities", far from science and free debate, have become militant, where anyone who thinks differently is an enemy to be silenced, even to be professionally killed.

There remains justice and the courts to put some order in there, do you think? Oh no! The question in the United States was decided in 2010 by the Supreme Court, also a victim of ideological contamination.

Citizens United v. Federal Election Commission, released by the United States Supreme Court on January 21, 2010, is a landmark decision regarding the regulation of campaign spending by organizations.

The Supreme Court has ruled that the First Amendment freedom of speech of the United States Constitution prohibits the state from restricting the expenditure of communication that expressly advocates the election or defeat of a clearly identified candidate who does not is not made in cooperation, consultation or concert with or at the request or suggestion of a candidate, a committee authorized by the candidate or a political party (independent expenditures), for not-for-profit corporations , for-profit corporations, trade unions and other associations.

In April 2014, in McCutcheon v. Federal Election Commission, the Supreme Court also found contrary to the First Amendment the cap on donations made by an individual to multiple candidates, set at $123,200 per two-year election cycle. However, it maintains the limit on donations from individuals to $5,200 per candidate. During the hearings, Judge Antonin Scalia considered in particular that these ceilings "did not prevent large sums of money from pouring into politics", because of the possible financing of the organizations.

The decision put a dollar sign on our democracy, opening a flood of corporations, special interests and even foreign money into our politics. The Supreme Court came to open Pandora's box of the oligarchy and offered democracy to the oligarchs and plutocrats on a silver platter. We have seen the proliferation of super PACs, which can accept and spend unlimited amounts of money to influence elections, and the rise of black money, which is undisclosed political spending that can come from any vested interest, including including foreign countries. The Supreme Court "genetically" altered the democratic DNA, pushing America toward corporatism and oligarchy."

Two fundamental principles
The trick of the court's genetic modification was to remove two fundamental principles from the First Amendment.

First, our rights as equal citizens, with free speech rights no more and no less than anyone else's. You may think that our equal rights to speak and be represented are important enough to weigh the balance of the First Amendment against the power of money. The Court says no, your political equality as a citizen has no bearing on the matter.

It's quite radical. The idea of political equality, that we have inalienable and reciprocal rights because we are equal human beings in society together, dates back to the Declaration of Independence. This is the whole reason of the United States of America. Our political equality contrasts with the system that our American Revolution rejected: an aristocracy, a wealthy political class, which sets the rules for everyone.

The second genetic modification made by the Court to the National DNA DNA was to remove the consideration of systemic corruption from the First Amendment balance. The Court has said unlimited campaign spending by Super PACS, corporations, unions, or the wealthy does not cause corruption or the appearance of corruption. Why not? Because the court said so. But saying it doesn't.

The idea that a democracy can turn into a dictatorship is very old. It is found, for example, in Plato. For Plato, the ideal regime is aristocracy, which eventually turns into timocracy (a form of government of those who seek honors), then into oligarchy, then into democracy, then finally into tyranny.

What is current (among others) in Plato, is the notion that political regimes are born, live and die. His conception of democracy is also quite interesting. For him democracy occurs when in an oligarchic regime the dissatisfied are very numerous. From then on, democracy took hold and it eliminated the rich. Eventually, a democracy fails because the taste for freedom is so strong that it leads to despising officials (specialists), laws, and all ways of life becoming morally equivalent.

On the other hand, the succession of Plato's political regimes should make us reflect on the exact nature of the current political regime of the American central government. There are many who argue that the United States has long been an oligarchy, not a democracy.

Plato basically encourages us to ask the only question that really matters: who holds the real power? Or when mediocracy slides into plutocracy. But in fact, what is plutocracy? The dictionary tells us that the term comes from the Greek words ploutos, "wealth", and kratos, "power". A regime would therefore be plutocratic when power is exercised by the richest.

The term therefore does not lend itself well to a rigorous use which would describe precisely a way of exercising power, such as the use made of the words "monarchy" or "communism". One could even consider it a truism: it would indeed be difficult to find a model of government that did not rely on the richest people. The sound of the term "plutocracy" is unpleasant, aggressive, and the word slams like an insult. Few people would like to be called "plutocrats". The term was also often used by the Nazis and the Fascists in fiery demagogic outbursts, to shame the big bourgeois and their collusion with power.

The word "plutocracy" seems to have been in common use in 19th century France. Pierre Leroux, socialist intellectual and friend of George Sand, published In 1848 Plutocracy or The Government of the Rich, a slightly misleading title, since the author does not really begin a reflection on the subject, but develops a detailed study of the social classes in France. A few years later, Ernest Renan gave us a definition often taken up: "I call plutocracy a state of society where wealth is the main nerve of things, where one can do nothing without being rich, where the main object of ambition is to get rich, where ability and morality are usually gauged (and with more or less accuracy) by fortune."

Two models: the United States and Russia

This definition takes us somewhat away from the idea of political power exercised by the rich, but brings us back to the United States of Marcy Kaptur. Our neighbors' obsession with money and desire to get rich have been denounced many times, from Tocqueville's stay in America to the devastating observations of Joseph Stiglitz in When capitalism loses its head: "[we] counted a lot about foreign students flocking to universities to run our research institutes, while top American students learned how to mount financial transactions."

Because it is certainly necessary to have money, a lot of money, before undertaking an electoral campaign in the United States. With a few bows, the purse strings of big companies and millionaires are easily untied. One can imagine that such generosity will be nobly rewarded. To ensure that elected officials do not go off the rails between elections, to prevent it from taking the will to govern in the interest of the majority, large companies use a very effective process, but which is obviously very expensive: lobbying.

In Washington, lobbyists form a veritable army: there are 25,000 duly registered lobbyists representing 600 organizations, and this structure is repeated, on a smaller scale, in each of the 50 states. All of these lobbyists do not work for large companies and sometimes defend noble causes. But since the most influential among them - those who guarantee you safe contacts with the powerful - can easily obtain salaries that exceed $300,000 a year, one imagines that few community groups or citizens' organizations really manage to benefit.

It is well known that the most powerful lobbies, for example the National Rifle Association, the lobby of pharmaceutical companies and the US Coalition for Service Industries have important entries in the White House and that many policies with regard to major subjects , such as the environment, the liberalization of services, the sale of arms, are determined according to the desires formulated by extremely wealthy companies. Money opens many doors. Who wouldn't be tempted?

Russia

Since the transition of the Russian economy towards a market economy, with in particular the privatizations during the two terms of President Boris Yeltsin, the terms "oligarch" and "oligarchy" have replaced those of apparatchik and nomenklatura used in the Soviet era. In Russia, oligarch designates the leading figures in the business world, in connection with political power, who have become rich since the breakup of the USSR. An associated and complementary term, but which is not reserved for prominent personalities, is that of plutocrat which comes from the French "new rich".

In Russia, where the state has never confined itself to the sole functions of governance, but has also ensured the distribution of public goods, statism is a deeply rooted tradition. Customer relations have also become a fundamental component of political culture, as certain concepts emphasize. The best known is the so-called "state service" (slu□iloe gosudarstvo), traces of which can be found as early as the 16th century - the state provides its "servants", or slugi, with wealth and social status in return for services rendered. The gentry relied fully on this system.

In post-Soviet Russia, this patronage system was reincarnated with variants through "oligarchic capitalism". The oligarchs, who then became the new clients, not only acquired goods from dubious auctions, but also gained a voice in privatization decisions thanks to their access to the "body" of government. They thus exerted considerable influence on the political decision-making process thanks to the financial "shadow cabinet" through which the oligarchs managed to take control of the formation and functioning of the Russian government. This 'state capture' had the disastrous consequence of the total deprivation of the state as a domestic political actor.

Some analysts believe that the protection enjoyed by the Russian oligarchs by Western countries, under the guise of human rights or fair justice, is directly related to the period of privatization and the rapid enrichment and billions of dollars from these oligarchs. The tax evasion of the fortunes of these oligarchs towards Great Britain, the United States or Israel, sometimes mixed with presumed transmissions of secret documents of State to the secret services of the countries would constitute the real reasons for this Western protection.

It's quite radical. The idea of political equality, that we have inalienable and reciprocal rights because we are equal human beings in society together, dates back to the French Revolution in Europe and the Declaration of Independence, reason for the United States. United of America. Our political equality contrasts with the system that these two revolutions rejected: an aristocracy, a rich political class, was its own creator: by that it takes from God. What makes man specific is his existence, his freedom, this power to give himself, by himself, an essence. To be is therefore to make oneself, to construct oneself over the course of our knowledge and experience. These, then, are the precepts of a concept that was called altruistic humanism of a pacifist nature, a cooperation which will experience phenomenal expansion and which will be fought against by selfish cheaters.

The world is becoming a veritable open bar. Nearly 70% of international stock market transactions are only speculative transactions that do not bring any added value to the economy and therefore in extenso to society. All these operations aim only to take a quick profit.

Income and wealth inequality have not been so high for 20 years. Less in France due to greater redistribution, this phenomenon calls into question the "Trickle down Economic" trickle-down theory, which states that favoring the rich is good for the poor.

In English this is called Trickle Down Economic, and indeed it is the idea that wealth as a source divides into multiple small channels and trickles down, allowing EVERYONE to benefit from the wealth created above, including the poorest. It's a liberal theory, it roughly assumes that the richer the rich, the poorer the poor. This theory has lead in the wing when we observe the facts, worse, it is the scam par excellence to rip off the poor workers.

The same is true for the criminal mind. Criminals are essentially predatory behaviors that roam the public space looking for the next opportunity to commit a crime. The criminal instinct propels us towards an anthropological regression of the cave man. When a hunter-gatherer chooses to stalk a wildebeest rather than a gazelle, the behavioral mechanism is the same as when a criminal chooses to steal a Lexus car rather than a Honda.
No wonder the top 1% owns over 99% of the world's population. The super rich are getting richer and the poor are getting poorer, according to a report by international charity Oxfam.

The charity says concern from world leaders over the escalating inequality crisis has so far failed to translate into concrete action. "The world has become a much more unequal place and the trend is accelerating," said Oxfam International Executive Director Winnie Byanima.

"We cannot continue to allow hundreds of millions of people to go hungry while resources that could be used to help them are sucked away by those at the top," Byanima added.

The wealth of the richest 62 people has increased by 44% since 2010, while that of the poorest has shrunk by a corresponding figure, according to the international charity.

About $7.6 trillion of people's wealth is in offshore tax havens, and if taxes were paid out of the revenues generated by this wealth, an additional $190 billion would be made available to governments each year.

The report claims that up to 30% of all African financial wealth is held offshore, costing an estimated $14 billion in lost tax revenue each year. That's enough to pay for health care that could save the lives of 4 million children a year. Almost half of the super-rich individuals come from the United States, 17 from Europe and the rest from countries such as China, Brazil, Mexico.
How did we get here?

Most of us nevertheless make an effort to pay attention to the people who share our daily life: a furtive glance in the subway, a smile on a street corner...

Less concern for others
A growing number of studies show that we are not all in the same boat. Being rich would change the way we see the world: the more money we have, the less attention we pay to others and their problems.

A 2016 paper published in the scientific journal Psychological Sciences tasked sixty-one participants decked out with Google Glass to walk along a New York neighborhood block. Result: wealthy people look less at others than those from another social class.

"The studies carried out online, in the field and in the laboratory all lead to the same conclusion: the rich are less concerned about others than other social classes," says Pia Detze, the main author of the study relayed by Quartz.

Emotional distance

Other work on the subject reveals that wealth also acts on the ability to feel compassion.

In 2012, students were subjected to a test set up by psychologists at the University of Berkeley, California. The wealthiest students expressed less empathy when watching a video showing children with cancer than the other study participants.

How to explain this emotional distance? According to Daniel Keltner, professor of psychology at Berkeley, being able to hiring staff to serve their needs cuts off the better-off from any relationship of dependence on the other - in short, the wealthy pay for a service rather than asking a neighbor for help.

This translates socially into the privatization of public services. Let's take the example of two-tier medicine: a private system that is better equipped and therefore more efficient than an underfunded public service. This disparity between the wealthy classes and the other social classes poses a real problem at the economic level: if the richest continue to become richer and richer and if they continue to ignore the poorest, inequalities will continue to grow. . In a column for the New York Times, psychologist Daniel Goleman declared that it is impossible to reduce the economic gap without dealing with the empathetic gap between social classes.

Capitalocene and environment

Capitalism is very effective at ingesting, digesting criticism, normalizing situations, limiting extreme cases while giving us the impression of having understood everything. For example, to include major principles in the constitution without considering the modes of production and life, is to be sure that capitalism will swallow the rights of nature raw. The contemporary environmental crisis requires action in the political and geopolitical world as it currently exists. What needs to be done is quite obvious: subdue polluting and extractive lobbies and companies, leave the carbon in the soil, stop industrial agriculture, implement ecological rationing (on CO2 for example), change the system taxation, changing modes of transport and food, punishing damage to the environment with equal severity as damage to property and persons. It doesn't sound revolutionary compared to "concrete utopias" and projects for cosmological change, but perhaps more so in the end.

Obviously, the way in which one acts on the environment of the enemy to destroy it is very old, even if it takes on considerable industrial and technological proportions with the war in Vietnam. The most important thing is to what extent the military fact contaminates civilian technologies. And as it is oriented towards the choice of power rather than that of performance, it leads to a shift towards very energy-intensive, very polluting technologies. The same technologies of destruction against humans are then applied to the living in general: pesticides, the nylon line used for fishing comes from parachutes, aviation, highways, all very polluting elements that come from the military. The interaction of all this with capitalism is the crux of the matter.

The history of energy seems to be accompanied by a search for greater efficiency. You take an example that undermines this idea: intensive and mechanized agriculture is less efficient - energetically speaking - than traditional agriculture, since more calories must be supplied to produce one food calorie. Is energy progress a myth?

The energy system may not be efficient without it mattering: if there is plenty of energy for cheap, who cares, that's the problem. As long as there is cheap oil, we can transform a lot of oil to recover an agricultural product that contains little energy... Agriculture is exactly that: industrial cultivation can be energy-deficient - there is still debates, depending on what we compare, which cereals, which products - but that does not prevent him from conquering the world.

That's also why the talk of energy companies saying it's the end of the party because the EROI (Energy return on investment) is decreasing - you need more and more calories to recover a calorie of oil - never seemed very conclusive to me. If we take the EROI of the first coal mines, it is disastrous: water had to be pumped and there was a lot of humans who worked in these mines (close to a million miners in England at the end of the 19th century). Yet it was these energetically inefficient coal mines that launched fossil capitalism. So there were trajectories that started on very bad EROIs. Whatever the EROI, as long as there is a financial interest in doing it, we will do it. In the late 2000s, oil companies seriously considered installing nuclear power plants to recover bituminous oil from the province of Alberta, Canada. And if the price of oil goes up, there is a chance that these projects will reappear. It is necessary to take into account the EROI but also to relativize this purely energetic vision of the history of energy. It is rather the political histories of energy which show the strategic, capitalistic stakes, etc., which are much more important explanatory factors.

If the quantification and the putting of a price on nature extend widely today, certain principles, such as that of the "polluter pays", are old. When did this idea come from?

This business of compensating for the damages for which one is responsible is an old idea of Roman law taken up by the elites of industrial capitalism at the beginning of the 19th century. From the beginning of the industrial revolution, there is a very important project of stabilization of industrial properties, with solid property rights. And therefore, whatever the complaints against pollution, the manufacturer must be guaranteed in his right to practice and must not be forced to move. The "solution" that is put in place, with the decree of 1810 on classified establishments, consists in granting damages to those who suffer nuisances. As we know, this does not solve the problem of pollution but it calms neighborhood disputes. It's an obvious smoke. Today, it takes much more impressive, more subtle forms, with the idea that we can even compensate for the loss of ecosystem services (how much is worth not a meadow, but the pollination activity of the insects that live there? live, for example); the logic remains fairly equivalent - and so does the end result. What is dangerous in these cases of ecosystemic compensation is the equating of financial values and nature, it is a mode of disinhibition, we give ourselves a clear conscience by saying "We are going to concrete here and protect there". Reality ? We risk concreting here and later there.

Since the 19th century, many things have been invented to protect nature: the ban on fishing, deforestation, excessive pollution, etc. These are very old tools. In the 19th century, especially in the United States, natural parks were created with the desire to preserve a place outside of economic logic. The park has been heavily criticized by post-modern historians and philosophers. By historians, because in the 19th century, the parks were also used to drive out the people who lived there, the Indians in the United States in particular, and their land was taken from them under the pretext of preserving nature. By the post-moderns since that meant separating nature from man. I understand their arguments, but it remains an effective environmental protection tool and it is important to rehabilitate it. Similarly, all the corridors to allow animals to migrate, to move, to reproduce: there is no financialization of nature, we are not trying to promote an ecosystem service - we are thinking about the right organization of human activities to prevent them encroaching too fundamentally on those of other species.

The notion of "sustainable development" is now fairly criticized, but another expression is less questioned, that of "energy transition.

"We don't go from wood to coal, then from coal to oil, then from oil to something else: we just add these sources of energy together. "

The term "energy transition" appeared in English around 1975, to replace the notion of energy crisis: it is much more reassuring and it gives the impression that there is a kind of managerial rationality.

It comes from energy companies and nuclear energy professionals. They say that if there is not enough oil - we have passed the peak of conventional oil in the United States - we will do nuclear power, coal to fuel (liquefaction of coal to make oil), shale oil. This notion of energy transition was then reused in the 1980s, especially in Germany ("energy turning point"), to designate the transition to renewable energies with solar, wind power - even if, behind it, it is a very naive about what an energy system is. It is a notion that has served to allay fears. The second problem is that historically there has never really been an "energy transition" but above all "energy additions". We do not go from wood to coal, then from coal to oil, then from oil to something else: we have only added these sources of energy to each other. The coal peak did not take place in the 19th or even the 20th century, let's hope it will soon take place in the 21st century... When we speak a little too lightly of "energy transition", we have to realize that it This is an unprecedented transformation.

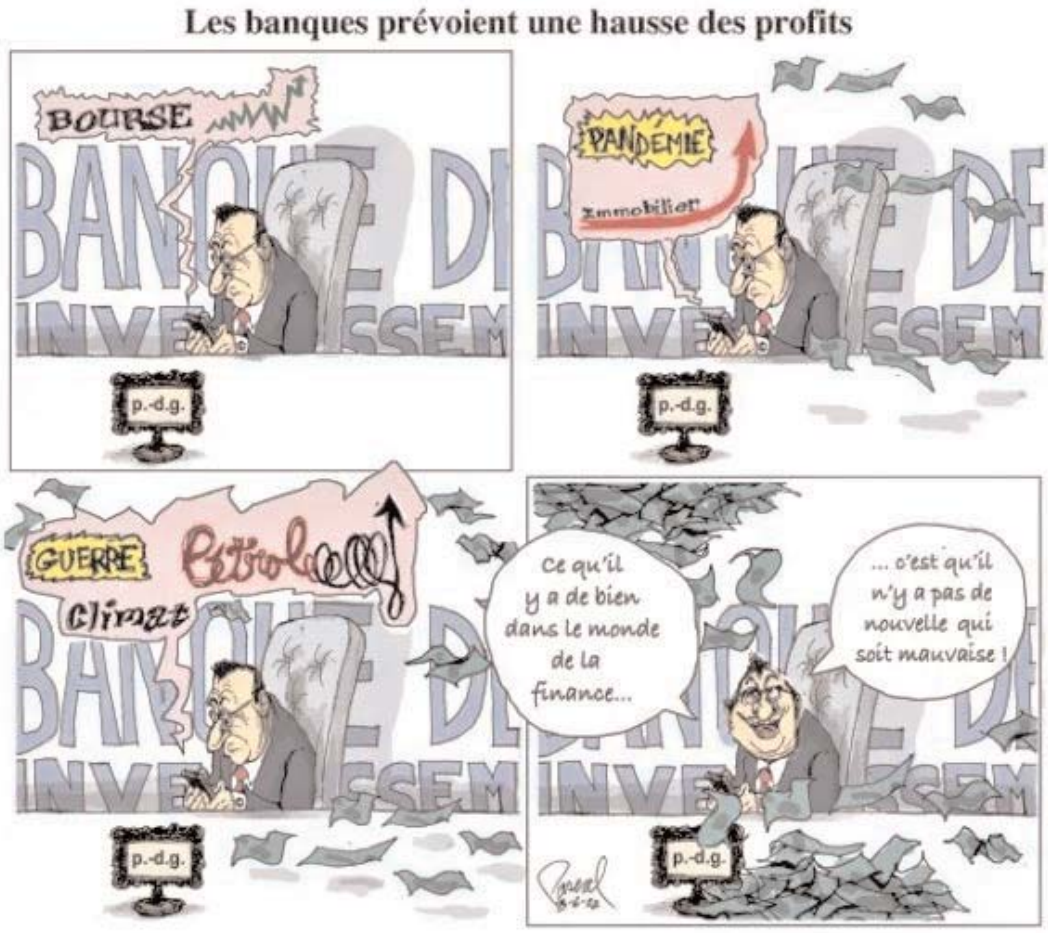
There remains the question of innovation: you should not be technophobic because there is no reason to be more wary of a new technique than of the old techniques which have put us in the situation we know. But we must not be naïve either: given the considerable inertia of technical systems, given once again the urgency (to reduce global emissions by 75% before 2050), the probability that "green innovation" will kind of crisis seems close to zero to me.

So let's come to the case of Homo sapiens. Several philosophers, theologians or biologists converge to show that, fundamentally, men are subject to the laws of nature, those of pure and hard selfishness. But they also converge to give birth to a hope, no longer that of a hypothetical paradise, but quite simply that of a culturally determined behavior, capable of replacing selfishness with genuine altruism.

The dream is "Love your neighbor as yourself". The reality is "Well-ordered charity begins with oneself".
Is it possible to go from reality to dream? From genetic selfishness to cultural altruism?

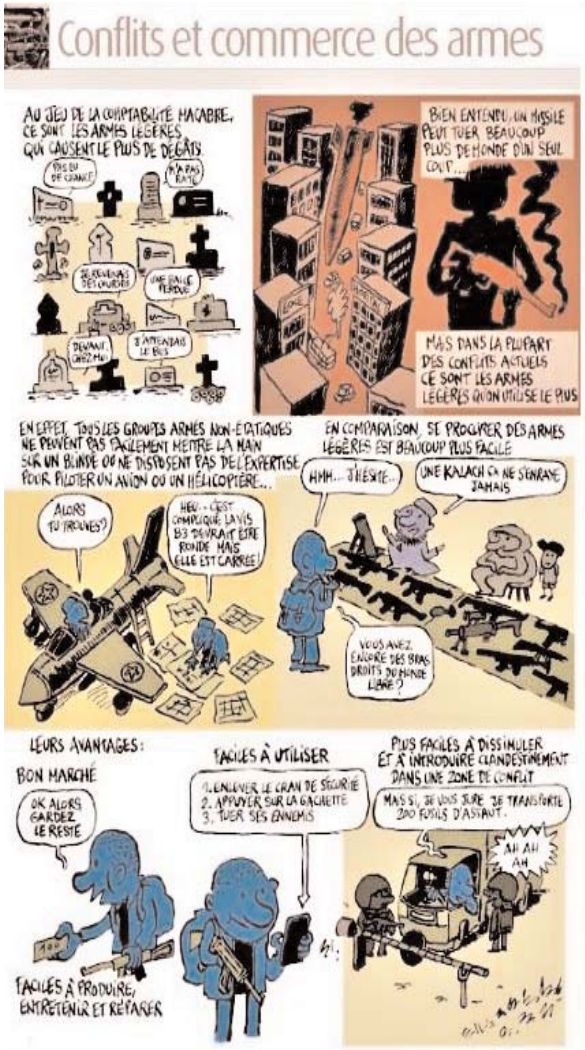
Of course, we are touching here on the Challenge (with a capital D) which has been posed to human society since its origins, since men have tried to oppose their laws to natural laws. For the philosopher Patrick Tort, this reversal of man against biological laws is nothing other than the ultimate product of natural selection. He qualifies it as a reversal effect of evolution and links it to emergence of human intelligence: "A reversal has taken place in man as the civilizational process of natural selection, as an evolving mechanism, subjugates itself, from this fact, to its own law".

In fact, the dilemma is simple. Either human intelligence puts itself at the service of natural laws



(social Darwinism, the law of the jungle, deregulation, globalization), or else it fights them (remember the words of Thomas Huxley). In a humanity where all sorts of factors generate inequalities, intelligence placed at the service of competition is the most formidable weapon that evolution has ever produced. Power breeds contempt. This is what allows the yran to put to death the servant who displeases, the racketeer to buy a child to take his eyes, to others to think that the world would be much more peaceful if we killed the unemployed and the poor. Obviously, put at the service of altruism, the same intelligence could work, literally speaking, miracles.

The concept that man is fundamentally neither good nor bad (remember: good and bad have no biological meaning), but can become either good or bad (culturally speaking that goes without saying!) is the only one that the biologist can endorse. "To become good" is to accept human laws, it is to accept the "Thou shalt not steal" even less to "kill one's neighbour" even if it is against nature.


Conflits et commerce des armes
AU JEU DE LA COMPTABILITÉ MACABRE, CE SONT LES ARMES LÉGÈRES QUI CAUSENT LE PLUS DE DÉGÂTS
BIEN ENTENDU, UN MISSILE PEUT TUER BEAUCOUP PLUS DE MONDE D'UN SEUL COUP...
MAIS DANS LA PLUPART DES CONFLITS ACTUELS CE SONT LES ARMES LÉGÈRES QU'ON UTILISE LE PLUS
EN EFFET, TOUS LES GROUPES ARMÉS NON-ÉTATIQUES NE PEUVENT PAS FACILEMENT METTRE LA MAIN SUR UN BLINDÉ OU NE DISPOSENT PAS DE L'EXPERTISE POUR PILOTER UN AVION OU UN HÉLICOPTÈRE...
EN COMPARAISON, SE PROCURER DES ARMES LÉGÈRES EST BEAUCOUP PLUS FACILE
ALORS TU PROUVES?
HEU... C'EST COMPLIQUÉ LA VIS DEVRAIT ÊTRE RONDE MAIS ELLE EST CARRÉE!
HMM... J'HÉSITE...
UNE KALACH ÇA NE S'ENRAYE JAMAIS
VOUS AVEZ ENCORE DES BRAS DROITS DU MONDE LIBRE?
LEURS AVANTAGES:
BON MARCHÉ
OK ALORS GARDEZ LE RESTE
FACILES À UTILISER
1. ENLEVER LE CRAN DE SÉCURITÉ
2. APPUYER SUR LA GÂCHETTE
3. TUER SES ENNEMIS
PLUS FACILES À DISSIMULER ET À INTRODUIRE CLANDESTINEMENT DANS UNE ZONE DE CONFLIT
MAIS SI, JE VOUS JURE, JE TRANSPORTE 200 FUSILS D'ASSAUT.
AH AH AH
FACILES À PRODUIRE, ENTRETENIR ET RÉPARER

Conflits et commerce des armes
AU MOZAMBIQUE PAR EXEMPLE, PAYS DÉCHIRÉ PAR PRESQUE TRENTE ANS DE GUERRE D'INDÉPENDANCE PUIS CIVILE, ON COMPTABILISAIT DANS LES ANNÉES 90 PLUS D'UN FUSIL AUTOMATIQUE PAR HABITANT. À L'ÉPOQUE, UNE KALACHNIKOV SE TROUVAIT POUR À PEINE 15 DOLLARS.
CETTE ARME EMBLÉMATIQUE DE LA GUÉRILLA EST TELLEMENT RENTRÉE DANS LA CULTURE DU PAYS QU'ELLE FIGURE DÉSORMAIS SUR SON DRAPEAU AU RANG DE SYMBOLE NATIONAL!
LES ARMES LÉGÈRES SONT AUSSI TRÈS SIMPLES À UTILISER... IL SUFFIT DE QUELQUES MINUTES DE FORMATION POUR SAVOIR S'EN SERVIR. C'EST BEAUCOUP PLUS SIMPLE QUE D'APPRENDRE À LIRE
A COMME...
AK 47
L'AK 47 POUR QUE LE PEUPLE PROTÈGE SA LIBERTÉ
LA HOUE POUR L'AGRICULTURE
LE LIVRE POUR L'ÉDUCATION
C'EST BIEN
LA PREUVE? DES MILLIERS D'ENFANTS SOLDATS S'EN SERVENT ENCORE AUJOURD'HUI SUR DIFFÉRENTES ZONES DE FRONT: EN AMÉRIQUE DU SUD, EN AFRIQUE, AU MOYEN-ORIENT ET EN ASIE. DES MINEURS SONT ENCORE UTILISÉS AU SEIN DE CONFLITS ARMÉS DANS UNE VINGTAINE DE PAYS...

This acceptance requires a benefit-cost ratio, a very simple concept with which all ecologists are familiar. For a decision to be taken by a living organism, the benefit of this decision must be greater than the cost necessary to implement it. The word "decision" is now commonly used by biologists for any organism. When a biologist writes, for example, that a pair of chickadees make the decision to reduce or increase the size of their brood depending on the circumstances, it does not imply that this decision is the result of reasoning, but simply that natural selection has given the bird the ability to adapt its brood size based on signals (temperature, food availability, etc.) received from its environment.

In the case of humans, nothing prevents the benefit, capable of offsetting the cost of the altruistic act, from being purely cultural.

The self-satisfaction provided by the "gesture towards the other", the hope of future reciprocity, the well-being provided by the feeling of solidarity, can offset the cost of the gesture. It is easy to denigrate this form of altruism on the grounds that it is not "true" altruism since it is dependent on a reward (material, intellectual or emotional). But this way of seeing (to denigrate this form of altruism) is precisely the one which leads modern society towards non-civilization. Civilizing means accepting the constraints of our genome, which only give pride of place to the individual, and balancing them with cultural constraints. To civilize is to make man a rebel of evolution.

To rebel against evolution is to favor the instinct of life to the detriment of the instinct of death because "we are not obliged to obey our genes". Eros or Thanatos?

Unfortunately, too often Thanatos wins out because we are unable to culturally subjugate ourselves to "warrior genes".

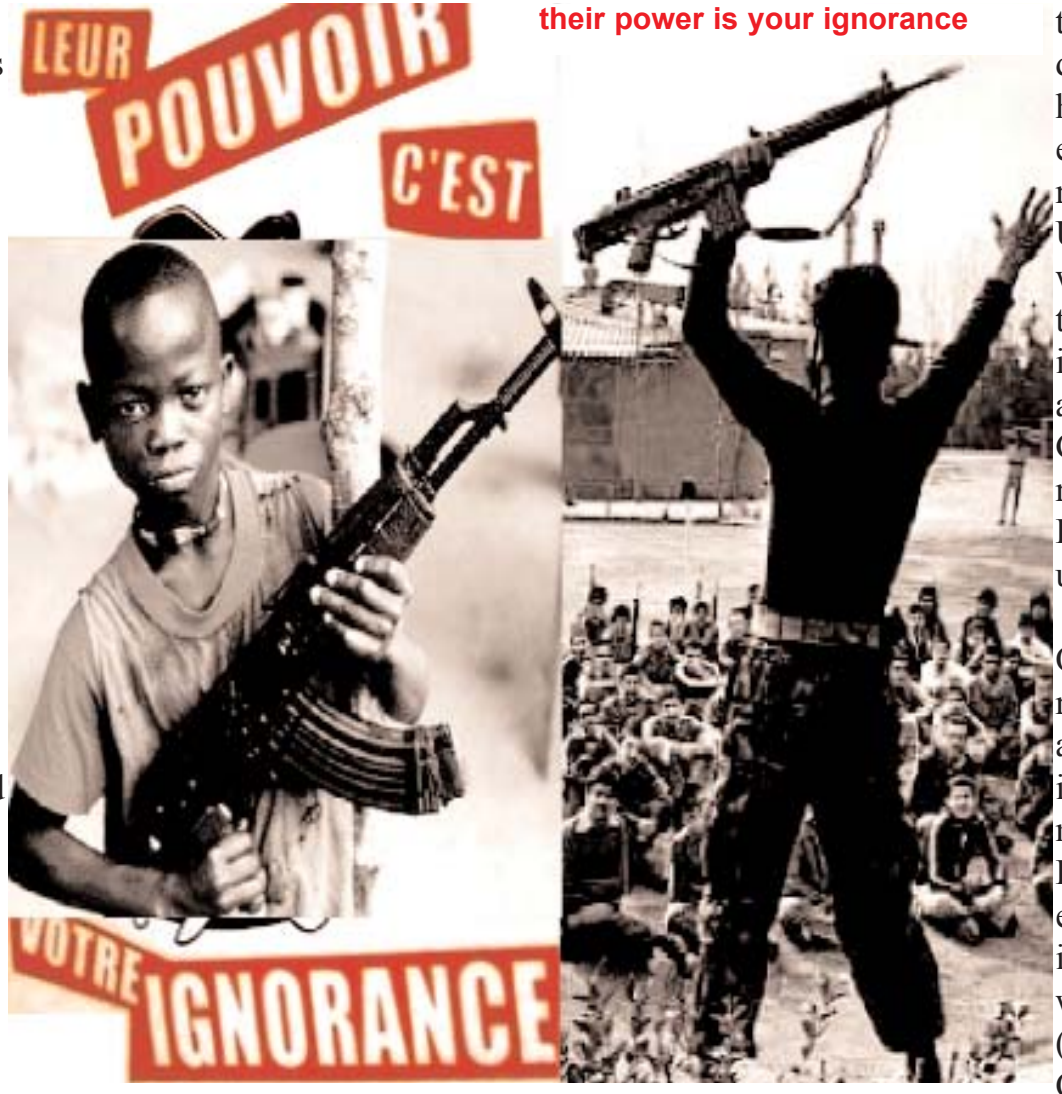
There is history only because there are men. However, it is surprising to note, from a rationalist point of view, that the historical process of Humanity, from the night of Ancient Times until our century, is actualized in a constant quest for power through the mastery of nature and its forces, like a ridge line coming from the past which intrinsically carries the seeds of the future.

It is not a question of discovering a unique turnkey model (a single design), there are hundreds of them around the world on all continents, but rather of understanding why the Western model of power-seeking, in its rationalist, capitalist, and patriarchal constancy, rules the world; why his sickly, neurotic bulimia, like an ogre, swallows everything in its path and what the consequences will be in our immediate future. Looking at the United Nations statistics on North-South disparities, on life expectancies, on endemic diseases, on the economic precariousness of ¾ of humanity, on injustices and inequities, we guess that one day everything will farting, bursting into a thousand pieces, all we hope is that it doesn't blow us up in the face in our lifetime. Humanity is experiencing a general headlong rush of which we cannot be proud.

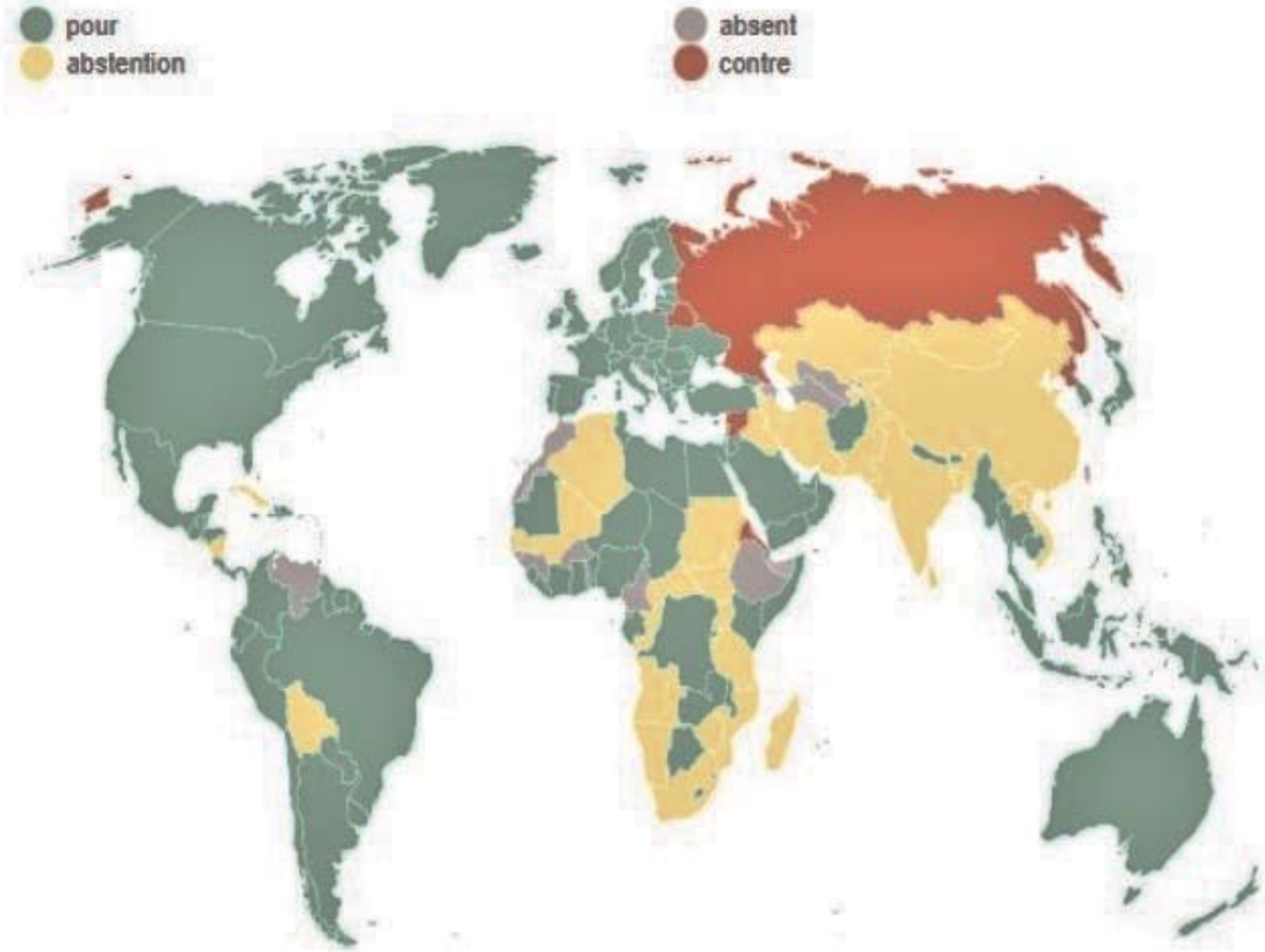
The vast majority of human societies throughout history have experienced war, to the point that the idea of a phenomenon rooted in "human nature" has become commonplace. It would also be more reasonable to attribute it to societies of primates, insofar as most groups of chimpanzees show phenomena analogous to open conflicts (fighting bands). But collective aggression seems to have been advantageous from an evolutionary point of view, since man is the only primate capable of coldly exterminating his fellow human beings. This thesis was defended by the ethologist Konrad Lorenz (1903-1989) and the prehistorian André Leroi-Gourhan (1911-1986) and, more recently, by supporters of the sociobiological approach such as Edward Wilson. It takes the direct opposite of the "Rousseauist" approach, according to which Man is fundamentally good and peaceful.

The idea of regulating the use of force has a history as old as civilization. The writings of Roman thinkers (Cicero: war should only be fought out of necessity) and above all Christians - notably Saint-Augustin (354-430) and Saint-Thomas Aquinas (1225-1274) - are among those who marked the Western tradition of the "just war". The current doctrine of the Catholic Church lays down four conditions for the legitimacy of the use of force:
the damage inflicted by the aggressor must be lasting, serious and certain; all other means must have proven impractical or ineffective; serious conditions for success must be met; the use of weapons must not cause evils greater than that which must be eliminated. In contemporary times, Michael Walzer has renewed the debate on the "just" war by proposing, in particular, the principle of "absolute urgency" (supreme emergency), which can, according to him, justify temporarily abstracting oneself from the rules established. It was at the beginning of the 20th century that the first serious attempts to regulate the conditions for the use of military force on a global level appeared, with the Hague Conventions and then the establishment of the League of Nations. The Charter of the United Nations implicitly restricts the use of military force to two scenarios: self-defence and mandated interventions. Self-defence is a right recognized by Article 51 of the Charter - even if it can only be provisional, until the Security Council has taken the measures allowing recourse to peace...As seen above, the number of wars has been declining since the end of the Cold War. This phenomenon must be "deconstructed", because it covers several realities that take place on different time scales and whose causes are not all identical. It essentially reflects the rapid decrease in the number of internal conflicts, which constitute the bulk of modern conflictuality.

Because - and this is the other notable trend - interstate war is increasingly rare. There have been fewer and fewer "general wars" since the 18th century, and fewer and fewer wars between states since the 1970s; we would find today a situation already known in modern times, but very rarely (the number of international conflicts per year has varied between 0 and 7 since 1816). The decrease in the number of civil wars can be explained by several factors. First, the completion of the decolonization process, as well as the creation of many new states (Eritrea, Republics of the former Yugoslavia, East Timor, Kosovo, etc.). Secondly, the end of the East/West confrontation, which meant both the end of the military and financial support given by the two Greats to many movements (an essential factor for around a fifth of the conflicts concerned). Then everything fell apart in 2022, with the invasion of Ukraine by the Russians. Europe is today facing a historic break with the war in Ukraine, with its families orphaned of their sons and its cities amputated of their heritage. Whatever happens to this conflict, by wishing it as short as possible, it marks for the Europeans the return of History, with its geostrategic imperatives which ignore morality and pious incantations...February 24, 2022 will figure as a secular turning point in the history of Europe... the war unleashed by President Putin concerns only Europe in the first place and poses new human and ecological challenges to all its inhabitants. This war of Vladimir Putin against Ukraine already has its share of drama, death and destruction. And among the collateral victims, "the environment could find itself in the front line, as the Russian bombardments and the clashes have already caused serious pollution and significant degradation. With contaminated waters, fires and radioactive leaks, Ukraine risks becoming an emblematic case of what historians call the "thanatocene", "an era of destruction and ecocides which has its origins in the war whose economic and political repercussions are global. The UN has demonstrated this... The war in Ukraine leaves two-thirds of the planet neutral or indifferent. On March 2, 2022, as with every conflict, the UN General Assembly passed a resolution that "demands that Russia immediately cease the use of force against Ukraine".



Of 193 states, 141 approved the resolution, 5 opposed it and 35 abstained. 12 did not participate in the vote. This apparently massive condemnation of Russia nevertheless deserves an explanation. In fact, if we take into account the respective weight of the different countries (Luxembourg weighs less than China), the vote of March 2 illustrates an imbalance in favor of Russia, with a splitting of the world into two blocks which moreover reproduces quite well that of the Cold War of yesteryear. This is shown in the map below.



o In green stand out the countries that condemn Russian aggression: the NATO countries of course, almost all of Latin America as well as the usual "customers" of the United States who cannot refuse them anything (Japan, Taiwan, Korea, Southeast Asia, Egypt, Israel, Arabia and the emirates), a few African countries… as well as the Taliban's Afghanistan, which keeps a grudge against the Russians, and Yemen, itself attacked by Arabia with Western support. These states bring together nearly 2.5 billion inhabitants. That's less than a third of the human population (7.7 billion humans in 2019).

o In yellow the countries which abstained and in gray those which preferred not to take part in the vote: China, Vietnam and Laos, India, Bangladesh, Pakistan, Iran, Central Asia, Iraq, Sudan, Ethiopia, Tanzania, South Africa , Angola and Mozambique, Madagascar, Senegal, Guinea, Mali, Burkina Faso, Algeria, Morocco, Venezuela, Bolivia...

o Finally in red the countries that reject the resolution: Russia of course as well as four dictatorships (Belarus, Syria, North Korea, Eritrea).

These divisions are not trivial. They signify that the grey, yellow and red states dispense not only with verbal condemnation of Russian aggression but also with associating themselves with the economic sanctions decided by the West, in Washington and Brussels. These States bring together more than two thirds of humanity. Suffice to say that Russia is far from isolated diplomatically, however unspeakable its aggression against Ukraine. At the very heart of Europe, Serbia has condemned Russia at the UN but is careful not to take sanctions against it and maintains its air links with Russia; in Belgrade, a minority is also not afraid to show its support for Moscow and Putin. It should also be noted, which is not negligible, that Turkey and Japan also refuse to apply any economic sanctions against Russia!

The return of the nationalism of the great powers, the contestation of the domination of democracies and the liberal international order, the rise of authoritarianism and populism… All this is not new. But it is only now that we are truly aware of the magnitude of the threat facing liberal democracies around the world. Starting with Ukraine.

"The last few weeks have reminded us in a rather brutal way that democracy is not guaranteed and that it can never be taken for granted," said Mélanie Joly. She's right. Vladimir Putin has reminded us how perilous it is to tolerate the ongoing democratic regression any longer.

What is at stake in Ukraine is "the direction that the history of humanity will take", even argued the famous historian Yuval Noah Harari recently. For him, it is "a moment of truth to determine if the period of prosperity and peace that we have known for several decades can last".

2. Democracy has not said its last word
Did Vladimir Putin bet that the democracies would not be able to agree to respond with one voice to his aggression? He was greatly mistaken.

While it is frustrating not to respond to fire with fire, so far the strategy of Western democracies seems to be working. Unlike that of Moscow. The Russian imperialist aims are coming up against the resistance of the Ukrainian people and the unity shown by the allies of Ukraine who, for once, are not fighting in dispersed order.

If the Russian tyrant persists in wanting to annex this country, it will cost him dearly. The awakening of democracies is also reflected in a desire to rearm. Seeing Germany decide to increase its military spending to more than 2% of its GDP shows us how much the world has changed. Other democracies now realize that if they want peace, they must prepare for war.

Russia's invasion of Ukraine has pushed the number of uprooted people worldwide above the 100 million mark for the first time, the United Nations warned on Monday. The invasion of neighboring Ukraine, thus throwing new millions of people on the roads to flee the fighting and to reach less exposed regions or another country.

This should serve as a wake-up call for us to resolve and prevent destructive conflict, end persecution and address the root causes that force innocent people to flee their homes, said UN High Commissioner United for Refugees, Filippo Grandi.

"The 100 million figure is startling. It's a sobering cause for concern. It's a number that should never have been reached."

The situation was already serious, as revealed by UNHCR statistics. By the end of 2021, the number of uprooted people worldwide had reached 90 million due to new waves of violence or protracted conflicts in countries such as Ethiopia, Burkina Faso, Myanmar, Nigeria, Afghanistan and the Democratic Republic of Congo.

Europe had not seen such a rapid influx of refugees since the end of the Second World War. Almost 6.5 million Ukrainians have left the country, mostly women and children, with men of fighting age expected to stay in the country. And the UN estimates that they could be 8.3 million by the end of the year.

In Ukraine itself, some eight million people are estimated to be internally displaced.

Prior to the Russian invasion, Ukraine had 37 million people in areas under its government's control. This figure excludes Crimea, annexed in 2014 by Russia, and the eastern regions controlled by pro-Russian separatists.

These 100 million uprooted people represent more than 1% of the world's population, and only 13 countries in the world have a popu-

lation greater than this number, recalls the UNHCR to give a better idea of the extent of the phenomenon. The situation in the world has never been so bad,

Two-speed solidarity

The response of the international community to people fleeing the war in Ukraine has been overwhelmingly positive. This surge of compassion is very real and a similar mobilization is necessary with regard to all the other crises in the world. However, the outpouring of generosity and the mobilization of public aid for Ukraine contrasts sharply with the much more mixed reception reserved for refugees from other theaters of war such as Afghanistan or Syria.

To reverse the trend, the only answers are peace and stability, so that innocent people are no longer forced to choose between the immediate danger of conflict on the one hand and flight and exile on the other. difficult.

Twenty countries which, more than two years after the start of the COVID-19 pandemic, continue to close their borders to asylum seekers in the name of health security. It is in fact an excuse not to reopen them.

A report by two NGOs, published on May 19, 2022, counted almost 60 million people internally displaced worldwide last year, many of them due to natural disasters.

Many African countries, including Nigeria and South Africa, are trying to help their nationals flee Ukraine overrun by the Russian military, amid growing accusations of racism against Africans at the borders Ukrainians.

Among the hundreds of thousands of people trying to flee Ukraine to neighboring countries, including Poland, are many African nationals - mostly students.

And the accusations of racist behavior towards them are multiplying.

The African Union (AU) has expressed particular concern over reports that African citizens, being on the Ukrainian side of the border, are being denied the right to cross the border to safety.

To apply unacceptable different treatment to Africans would be shocking and racist and violate international law, they point out.

Nigeria on Monday urged border authorities in Ukraine and neighboring countries to treat its citizens with dignity. Some Nigerians who crossed the border described their journey in darkness to crowded borders where officials prioritized Ukrainian women and children.

There are several ways to characterize contemporary conflicts and establish a typology. The simplest distinction, and probably the most important, is that which separates inter-state conflicts from intra-state conflicts (civil wars). But political analysis sometimes distinguishes two other categories, that of "internationalized" civil wars (which see the intervention of one or more foreign powers) and that of "extra-state wars" (colonial conflicts and other interventions against an actor non-state). We can also distinguish wars properly speaking from specific external operations (support for a regime in difficulty, peace enforcement, counter-terrorism, counter-proliferation, or simple "lesson" given to an adversary). In the contemporary period, American strategic thinking has proposed to speak of "asymmetrical wars" the conflicts which oppose a State to a non-State actor (asymmetry of actors) or two actors using different means, military or not (asymmetry of means) . Finally, from a legal and moral point of view, it is possible to distinguish between "wars of necessity" (which come under self-defence) and "wars of choice" (such as external interventions).

The number of conflicts since 1945, and the number of victims of these conflicts, are the subject of widely divergent estimates which depend on the criteria adopted and the sources used. Most of these show about 200 wars, and about 20 million casualties…

War and environment

Beyond the obvious humanitarian issues, armed conflicts raise important and crucial environmental issues. These issues seem increasingly obvious when we consider the immediate effects that massive population displacements or the setting up of refugee camps can have. In all other circumstances, population displacements, on a much smaller scale, are subject to a thousand precautions from an environmental point of view and constitute in themselves almost an entire field of specialization in environmental assessments. Moreover, situations of anticipated or open conflict, or the tensions which precede and accompany them, generally mobilize financial resources in the countries involved for armament or deployment and military strategy, resources which are no longer available for well-being and economic development of the people.
2Armed conflicts are also accompanied by a breakdown in environmental governance, which in turn leads to accelerated environmental degradation. In a few days, or in a few weeks, the long and patient work of several years, even the natural work of several millennia, can be destroyed. Sometimes destruction causes irreversible damage to ecosystems; this is the case when species may be driven to extinction, or fragile ecosystems may be irreversibly degraded, or resources irretrievably destroyed or contaminated. All institutional protection systems, such as Protected Areas or National Parks, become calling areas for displaced persons or combatants, with immediate and often irreversible consequences on the quality of these ecosystems.

3The environment cannot be the main concern when human lives are in danger or fundamental human values must be defended. However, after the conflicts, it is on the environment and its resources that the reconstruction will have to be based. For these purposes, we know the importance of water, biodiversity, forests and agricultural areas. The damage caused to these resources can lead, long after the conflicts, to harmful effects, even lethal, on the affected populations.

While the many deaths caused by wars are undeniably serious, several other environmental consequences occur during armed conflicts: soil erosion, destruction of forests, pollution of the seas, etc. These long-term consequences also become a scourge for the populations at the front.

When it comes to wars that have had a significant negative impact on the environment, three conflicts in particular have been recognized for the toxicity of their practices. First there is the Second World War, since the United States used atomic weapons in Japan. The Vietnam War, where "the massive use of 'Agent Orange' [one of the herbicides used by the U.S. military that caused vegetation death] destroyed 14% of [the country's] forests", is also important in this respect. Finally, she names the First Gulf War, which caused a major oil spill in the sea.
One of the most publicized contemporary conflicts is the Syrian conflict, triggered during the Arab Spring of 2011 by the violent repression of demonstrations. It is not yet easy to make a full assessment of the environmental impacts on Syrian territory, given that it is an unfinished conflict as of today. However, there are some studies to this effect. "The use of environmentally damaging weapons such as chemical weapons, the destruction of refineries or power plant factories have clearly harmed the environment". In addition to the environmental consequences, the effects of the war are materialized in particular by the wave of Syrian migrants at the Greek borders.

It is also difficult to establish with rigor the extent of the impact of wars on the environment since these are denounced more for the human losses they cause. However, if toxic technologies and pollut-

ing weapons degrade the territory on which they are used, other phenomena must be taken into account in the damage caused, among others "the displacement of populations towards natural or protected areas, since the fact of Settling in such territories leads to the exploitation of its natural resources, the accumulation of waste and the non-treatment of water". The destruction of houses and buildings also spreads residues of building materials into the air, soil and water, she adds.

Warning of a "spiral of self-destruction" in its report, the UN noted that these disasters stem from human-induced climate change - and from an underestimation of the risks, which leads to inadequate action. - were going to multiply at great speed.

While between 350 and 500 medium- and large-scale disasters have occurred each year over the past two decades, this number is projected to rise to 560 per year - or 1.5 per day - by 2030, it is projected . Disasters whose scale and intensity are increasing.

The report laments a misperception of the risks associated with natural disasters, attributed to a certain complacency, feelings of "optimism" and "invincibility" which take the form of an "underestimation" of the risks, perhaps we read in a text from Agence France-Presse.

Two days later, the UN published another report, this time devoted to agricultural techniques and unsustainable land use. Its Global Land Outlook highlights that food chains are responsible for 80% of deforestation and 70% of freshwater use worldwide - and are the main driver of the extinction of species.

It is added that at least 70% of the planet's ice-free land has been converted for human use (infrastructure, habitat, agriculture) and that most has been degraded, which increases CO2 emissions. "The report assesses different scenarios by 2050. In the absence of restoration and protection of agricultural land, if nothing is done, an additional 250 billion tonnes of CO2 equivalent could be released into the atmosphere, approximately four times the current annual greenhouse gas emissions," AFP continues.

The World Meteorological Organization, which also depends on the UN, made its contribution on May 9 with a bulletin indicating that there is a one in two chance that the average global temperature will be 1.5 ° higher. C to that recorded in the pre-industrial era for at least one of the next five years. It is reminded that we have reached 1.1 degrees of global warming; IPCC experts anticipate crossing the threshold of

1.5 degrees at the start of 2030, and 2 degrees by 2040.

Meanwhile, China announced on April 28 the abolition of customs duties on its coal imports. Caught last year with power shortages, the world's biggest GHG emitter set out to restart its coal production and ordered its mines to produce "as much coal as possible", reads a text from the press release. AFP. Coal-fired power projects have also been massively launched in 2021 to meet its energy needs and support its post-pandemic economic recovery. Overall, China's coal consumption increased by 4.9% last year.

Then India followed by announcing on May 6 the lease of a hundred dormant coal mines, all in response to an unprecedented heat wave.

Third largest emitter of CO2 in the world, India depends on coal for 70% of its energy needs. And the government wants to increase national production - which is already at a record high - by more than 50% over the next two years to support post-pandemic economic recovery. It is estimated that the country's coal needs will double by 2040.

Thanatos
The term "thanatocene" is attributed to the historian Jean-Baptiste Fressoz. The proposal, formulated in 2013, raises by a notch or two the damage to the environment and the seriousness of the consequences of human presence and action, the influence of which is already circumscribed in the concept of the anthropocene. Thanatos is the era of the end:

End of the partnership with Levy-Strauss:

"The world began without man and it will end without him. The institutions, the mores and the customs, which I will have spent my life listing and understanding, are a passing efflorescence of a creation in relation to which they have no meaning, except perhaps to allow humanity to play its role in it. Far from this role giving it an independent place and the effort of man - even when condemned - being to to oppose in vain to a universal decline, it appears itself as a machine, perhaps more perfected than the others, working for the disintegration of an original order and precipitating a powerfully organized matter towards an ever greater inertia and which will be a final day.

From the time he began to breathe and feed himself, to the invention of atomic and thermonuclear devices, to the discovery of fire - and except when he reproduces himself - man has nothing does more than cheerfully dissociate billions of structures to reduce them to a state where they are no longer susceptible to integration. No doubt he built cities and cultivated fields; but, when one thinks of it, these objects are themselves machines intended to produce inertia at a rate and in a higher proportion than the quantity of organization which they imply. As for the creations of the human mind, their meaning exists only in relation to it, and they will be confused with disorder as soon as it has disappeared. So that civilization, taken as a whole, can be described as a prodigiously complex mechanism in which we would be tempted to see the chance that our universe has of surviving, if its function were not to manufacture what physicists call entropy, that is to say inertia." Claude Lévi-Strauss, Tristes Tropiques, Presses Pocket-Plon 1955, pp.495 sq.

End of man with Foucault:

"Man is an invention of which the archeology of our thought easily shows the recent date. And perhaps the near end. If these dispositions were to disappear as they appeared, if by some events (...), they tilted, as did the ground of classical thought at the turn of the 18th century - then we can bet that man would fade away, like a face of sand at the edge of the sea. Michel Foucault, Words and Things, NRF-Gallimard, 1966 pp.396, 398.

Although he aspires to become God, man will always be condemned to imitation, to secondary imagination, to demiurgic "de-creation".

To think otherwise is a sham. (Plato)

Here again lurks the totalitarian drift inherent in any marginalized vision that wants to be soteriological in wanting to save humanity.

Through this deity complex, "the inhumanity of humanity", barbarism is actualized by the incessant and exaggerated use of the means of destruction available to the subject to fight his brother. As if by this neurosis the man had lost the secret which makes it possible to maintain the humanity of the man. As if our anxiety to exist were it that we declared war on life itself. We are witnessing today a real race against time towards the deity of man, the most fundamental neurosis of man. This deity complex being the neurotic response of man alienated by theologico-political dogmatism.

"Then evil shows its true face. (…) It is because man is targeted by totality, the desire for total accomplishment, that he throws himself into totalitarianisms which properly constitute the pathology of hope…" (Paul Ricœur, The Conflict of Interpretations, p. 429)

The Popes of the Inquisition, Hitler, Mussolini, Stalin, Mao, Hiro-Hito, bin Laden are all examples of absolutism. All of them provoked, by their will to be Savior, obscene events of unheard-of violence, a "true fury of destruction", a "fanaticism of devastation" where freedom annihilates itself. These psychopaths of the ultimate creation of the "neo-homo" are indeed madmen of the Absolute and each with their claim to save all of humanity used God, Allah or Yahweh as a surety or alibi for their crimes.

"Wherever finite entities internal to the world - once the 'nation', the 'people', the 'race', even the 'Church, today the 'working class', the 'party' or the ' true consciousness" of an intellectual elite - are set up as absolutes and held for the definitive emancipation, there does not occur the true liberation of man but the totalitarian domination of man over man, and therefore new suspicions and new hatreds, new anxieties and new sufferings among individuals, groups, peoples, races and classes: not a better society therefore, nor justice for all, nor the freedom of the individual, nor the true love. (Hans Küng, Does God Exist?, p. 565-566)

The will to power contaminates freedom by its desire for accomplishment because this aim of completion founds the hope by which freedom sinks into radical evil as a work of totalization. The deity complex as an apology for the desire for power is the defeat of the spirit.

"From the point of view of existential analysis, to claim to 'be like God' is to condemn oneself to neurosis. (...) Man will be more and more seized with fever: he must prove himself to himself his necessity, his equality with God, his certainty that "without him, nothing goes any more": He then overwhelms himself with ever more burdens, duties, demands, performance, multiplies fights and techniques, but thereby only increasing his feelings of guilt, only multiplying the reproaches he directs at himself, and all this only because in his disgust at being only a man, he pursues an absurd goal. " (Drewermann, 1996, volume II, p.10-11)

This desire for power turns against the human, life in general to the point where he begins to dream of another world, of another life. There is then an inversion of values where the instinct of life is supplanted by the instinct of death; hatred of existence mutates into hatred of freedom.

The seduction of disaster.

Devastated by two world wars, shaken by incessant conflicts that affect the entire planet, marked by the appearance of new weapons of mass destruction and the rise of new forms of totalitarian barbarism such as fascism, Nazism and Stalinism, the 20th century has deeply and seriously integrated the historical barbarism of antiquity. Evil is omnipresent in human history: mass exterminations of peoples "dedicated to the forbidden", search for domination and racial

or ethnic purity, slavery of the masses, enslavement of women as spoils of war and sexual object, forced labor of children, learned barbarism of weapons of mass destruction and chemical manipulations which increase the risks of humanicide. The biblical Nimrod is there to remind us: the excessive pride of self-divinized man in search of absolute power is our radical evil.

"Is God only an initiative of human freedom, in the same way as evil? As radical as evil elsewhere? " (Jorge Semprun, Evil and modernity)

Both theism and atheism come up against the efficiency of evil in the world. Having taken the place of God under the benevolent eye of the "Enlightenment" of modernity, man found a rational intention, a will to power in conformity with the final goal of his existence. From the deification of man as the spiritual foundation of modernity to the demiurgic temptation, the step was easily taken: the deity complex (man-god, master of the world) would be to modernity what the demiurge (god, creator universe) was in ancient times. The deity complex thus presents itself as a desperate attempt to compensate oneself for the experience of one's own nothingness (man is born once and dies forever) by the hubris of the demiurgic creation of a world. new. By wanting to be God, man discovered Nimrod.

"This is the perfect crime, perfect because the murderer and the victim are ultimately one and the same person." (Baudrillard)

"Today, and Nietzsche here again indicates the point of inflection from afar, it is not so much the absence or the death of God which is affirmed but the end of man; he then discovers that death of God and the last man are related.... Since he killed God, it is he himself who must answer for his finitude; but since it is in the death of God that he speaks, that he thinks and exists, his murderer himself is doomed to die: new gods, the same, are already swelling the future ocean: man is going to disappear. this death and according to a deep correlation with it, what Nietzsche's thought announces is the end of his murderer." (Michel Foucault, Les Mots et les choses, pp.396, 398)

The end of the apocalyptic world of theologies was relegated to an archaic superstition unworthy of modern thought, until the day... when man, that fallen god, fell back to earth, when he was joined by the events of his own tragedy. Now man can put an end to his story, to the story of humanity, the only and true end of "the eternal return."

The Apocalypses are all marked with a hot iron of anguish: "metaphysical anguish, anguish of neurotic origin, intimately linked and inseparable. Man seeks, through a disturbing darkness, to free himself from the heavy burden of his ambivalence instinctual. He tries, by expressing his anguish to flee it, to tame it, but, feeling dizzy, tirelessly returning to the images it arouses, he is fascinated by it." (Gauffretau-Sévy, 1965)

Evil is always defined as a separation, the rupture of a harmony, either in the same being, or between all beings. Between a science which, in its frantic race, seems to ignore the human, and a technology which worries and threatens it (nuclear, chemical weapons...), it is understandable to see impoesis settling in as a symptom of social unrest of our time, it means that the unhappy man will have willed and even created his unhappiness.

When will the apocalypse come? Our days on Earth may be numbered.

Indeed, by the end of the century, the world's population could begin its inevitable decline, argues paleontologist and Nature editor Henry Gee in a new article for Scientific American - and he doesn't hesitate to use the word " extinction ".

"I suspect that the human population is not just set to decline, but to crash - and very soon," he writes.

Gee points to the lack of genetic variation, declining birth rates, pollution and the stress of living in crowded cities as a recipe for disaster.

"The most insidious threat to humanity is what is called the 'extinction debt'", explains the paleontologist. "In the development of any species, however successful, there comes a time when extinction is inevitable, no matter what they can do to prevent it."

"The species most at risk are those that dominate certain habitats at the expense of other species that migrate to other places and therefore spread more evenly," suggests Gee. "Humans occupy more or less the entire planet, and by absorbing most of the productivity of this planetary patch of habitat, we dominate it."

Humanity's misperception of risk has led us into a 'self-destructive spiral', according to a new UN report. The report's authors also suggest that our future will be marked by an onslaught of everyday disasters by 2030.

The UN Global Assessment Report, released April 26, 2022, highlights some of the woes that await humanity due to misperceptions of risk stemming from a trio of thinking errors: optimism, underestimation and invincibility.

By consciously neglecting investments in disaster prevention efforts, while failing to act with sufficient urgency on related issues such as climate change, poor 'risk perception' can catalyze and aggravate disasters, making them more important and more far-reaching consequences than they would have been if the prevention and risk reduction efforts had been sufficient," said Jeanette Elsworth, spokesperson for the United Nations Office for Disaster Risk Reduction. (UNDDR), to Live Science in an email These disasters include earthquakes, tsunamis, and volcanoes; climate- and weather-related disasters; and outbreaks of biohazards, including crop pests and pests. outbreaks, Mr. Elsworth said.

Over the past two decades, 350 to 500 medium to large-scale disasters have occurred each year, the report's authors note. They predict that number will rise to 560 disasters per year (1.5 per day) by 2030.

"The world must do more to integrate disaster risk into the way we live, build and invest, which sets humanity on a downward spiral of self-destruction," said Amina J. Mohammed, Deputy Secretary General of the UN in a statement.

The authors point to the COVID-19 pandemic as an example of myopic thinking and lack of understanding of disaster risk. "Despite warnings and data indicating that a pandemic was imminent, preparedness was insufficient and governance systems around the world struggled to adapt to a new reality," they wrote. The severity of the pandemic has also been exacerbated by the exposure of populations around the world to other health risks. "Exposure to underlying risk factors, such as high levels of air pollution, substandard housing, or limited access to health services, has been found to significantly affect mortality rates," they wrote.

The authors also pointed to the growing risk of extreme weather events, which are becoming more frequent due to human-induced climate change. According to them, policy makers must strive to protect development and investments against climate change. For example, Costa Rica implemented a carbon tax in 1997 to help reverse deforestation, which reduces disaster risk and benefits the economy, the report's authors said. UN in the statement.

The authors found that not everyone is affected in the same way by disasters. Eighteen of the 20 countries with the highest disaster risk were middle- or low-income countries, with an average poverty rate of 34%. "By the end of the decade, climate change and natural disasters could push 132 million people into poverty," Ms Elsworth said.

But don't despair: the authors have developed a three-point action

plan to avoid this spiral of self-destruction. First, humans must stop undervaluing "the risk of climate change, the costs to ecosystems, and the positive social benefits of risk reduction," the authors write. The second action is to design systems "that take into account how the human mind makes risk decisions," they write. Finally, governments and financial systems need to work across disciplines to help people affected by disasters. Local leadership is essential during disasters, they wrote. "Dividing lines can appear between the national and local levels during major crises, as was the case in many jurisdictions during the COVID-19 crisis. Autonomy of action at the local level is essential."

The time for action, say the authors, is now. On the one hand, reaching Type I seems quite easy. Make power generation your top priority and eventually you will get there. But each type of energy source has its limits. In an extreme case, like burning every ounce of fossil fuel we can, it could lead to a level of climate change that could wipe us all out in what's called the Great Filter. You cannot become a futuristic civilization if you are on the verge of extinction and possess nuclear weapons.

Armaments: A landmark report predicts an increase in the global number of nuclear warheads, a first since the end of the Cold War. "All states equipped with nuclear weapons are increasing or modernizing their arsenals," worries the Stockholm International Peace Research Institute.

After thirty-five years of decline, a rebound is announced. The number of nuclear weapons in the world is expected to rise again in the coming decade, according to a benchmark report released on Monday (June 13). The risk of escalation is now at the height of the post-Cold War era, warns the Stockholm International Peace Research Institute (Sipri).

Since its absolute record in 1986 (more than 70,000 head), this total has been divided by more than five, with the regular decline of the enormous Russian and American arsenals built up during the Cold War. At the start of 2022, the nine nations with "the bomb" held 12,705 nuclear warheads, or 375 less than at the start of 2021, according to Sipri estimates.

But this era of disarmament is certainly coming to an end, predicts the Swedish research center. "Soon we're going to get to a point where, for the first time since the end of the Cold War, the number of nuclear weapons in the world could start to increase, which is a really dangerous phenomenon," Matt Korda said. , one of the co-authors of the work. After the "marginal" drop observed last year, the world arsenal should start to grow again "over the next decade", according to Sipri.

Nearly 6,000 nuclear warheads in Russia
The war in Ukraine has resulted in several explicit references by Russian President Vladimir Putin to the use of atomic weapons. Several other countries, such as China and the United Kingdom, are officially or unofficially carrying out modernization or development plans for their arsenals, the institute points out.

"It's going to be very difficult to make progress on disarmament in the years to come because of this war and the way Putin talks about his nuclear weapons," Matt Korda said. For him, these worrying declarations "urge many other powers having the nuclear weapon to rethink their own atomic strategies".

According to the latest Sipri estimates, Russia is still the world's leading atomic power, with 5,977 warheads (-280 over one year) deployed, stored or awaiting dismantling at the start of 2022. Nearly 1,600 of them would be operational, according to the institute. The United States has 5,428 heads (-120) but with more weapons deployed (1,750).

Next come China (350), France (290), the United Kingdom (225), Pakistan (165), India (160) and Israel (90), the only power of the

nine that does not officially recognize that it holds the atomic weapon. As for North Korea, Sipri estimates for the first time that the communist regime of Kim Jong-Un has assembled 20 nuclear warheads. Pyongyang has enough fissile material to produce about 50.

A Chinese arsenal doubled in five years?
Despite diplomatic statements, "all states equipped with nuclear weapons are increasing or modernizing their arsenals and most are toughening their nuclear rhetoric and the role of atomic weapons in their military strategies", according to Sipri. "In China, a substantial increase in the nuclear arsenal is underway, with satellite images indicating the construction of more than 300 new missile silos," the body said. According to the Pentagon, Beijing could have 700 heads by 2027.

The United Kingdom announced, last year, to raise the ceiling of its nuclear arsenal and decided not to communicate the number of its operational weapons. France launched a new nuclear submarine program in 2021, and India, Pakistan and Israel also seem to be developing their arsenals, according to Sipri.

WHY SUCH A DEPLOYMENT DESPITE THE NUCLEAR HORROR OF HIROSHIMA? IF NOT TO SEE THAT THANATOS STILL WINS THE BET ON LIFE.

Ultimately :

"Undoing, de-creating, is the only task that man can assign himself, if he aspires, as everything indicates, to distinguish himself from the Creator." (Cioran)

The Decreation explained (?)
We have lived terrorized by the Demiurge for too long, too long the perfection of his work has paralyzed our own initiative. But we don't want to compete with him. We have no ambition to match it. We want to be creators in our own, lower sphere, we aspire to the enjoyments of creation, in a word, to demiurgy. The Demiurge does not have a monopoly on creation: creation is the privilege of all minds. The material has an infinite fecundity, an inexhaustible force and at the same time a power of seduction which pushes us to shape it.

In the depths of the material imprecise smiles are drawn, conflicts are tied, sketched forms are condensed. It undulates entirely of unfinished possibilities which cross it with vague shudders. Waiting for an invigorating breath, it oscillates endlessly and tempts us with millions of soft and gentle curves born of its dark delirium. Deprived of its own initiative, malleable and lascivious, docile to all impulses, it constitutes a lawless domain open to innumerable dilettantisms to charlatanism, to all abuses, to the most suspicious demiurgic manipulations. She is the most passive, most disarmed thing in the Universe. Everyone can knead and shape it in their own way. We owe it to ourselves to penetrate all the currents conducive to the subjugation of the latter: art, science, philosophy, the economy and above all religion, the privileged place of all demiurgic manipulations and fanaticisms. Once these currents are well invested, politics will follow. Everything must be consumed.

All structures of matter are fragile and unstable, subject to regression and dissolution. We are corruption and the earth is our pandemonium. Reality will thus be perverted, evacuated in favor of a fictitious and burlesque frivolity of the Man-God.

Seduction of disaster.

The Demiurge was in love with solid, complicated and refined materials, such is his Universe. To beauty, we will oppose our fascination for ugliness. We will make the unnecessary a necessity. We prefer junk. We are attracted and positively seduced by junk, for all that is vulgar and unremarkable. Do you understand the deep meaning of this worship of idols, of this passion for the object, by this precedence of the object over the being: bulimia of the gadget, anorexia

of the feelings. Well, it's our idolatrous love for matter as such, for what it has that is fluffy, porous, for its mystical and unfinished consistency. We love its dissonances, its resistances, its rough-hewn clumsiness. In a word, we want to create man a second time, in the image of matter; the man-idol of himself: a mystical tautology in the excess and obscenity of the man-object. Narcogenic spectacle of technoscience.

Our creatures will therefore be in our imperfect image and thus called to life. We will give them for example only half a face, a leg, a hand, the one that will be necessary for their social role. It would be pure pedantry to worry about a second element if it is not destined to come into play. We will create the homunculus, the new fuel of mechanical society.

Our homunculi will be perfectly adapted to their environment. Through skillful genetic manipulation, the homunculus will form a generation of semi-organic beings nourished by photosynthesis. It will matter little to them that the snow is yellow, that the rains are acidic, that the obese architecture and structure of megalopolises are hurtful. Our creatures belong to the future, that is to say, adaptable to pollution, not caring about concrete, asphalt or the greenhouse effect let alone trees, plants and animals called anyway to disappear because replaced by our artificial clones: the pseudo-flora and pseudo-fauna. Evacuation of the organic.

We offer ourselves in sacrifice so that our creatures can live. Our spiritual and physical decreation is a necessary sacrifice for the "liberation" of our creatures into total and consented alienation by escaping this consciousness which, precisely, has made us human. Renunciation of reason, loss of self-awareness, return to the prenatal of the Universe, our accomplishment in the degeneration of human nature. Decreation guaranteed.

(The decreation explained is an adaptation of "Rue des Crocodiles" in "Les Boutiques de Cannelles" written by Bruno Schulz, Polish philosopher assassinated by the Nazis in 1942, Denoël Edition, 1974)

"Couldn't we then imagine that humanity is also a disease for some higher organism (the earth, the universe) that we are unable to grasp as a whole, and in which it finds the condition, the and the meaning of its existence? Seeking to destroy this organism and being obliged to destroy it as it develops, just as the microbial species aspires to destroy the human individual suffering from a disease (cancer) .

And are we not allowed to continue our reflection and ask ourselves if this is not perhaps the mission of all living communities, whether it is a question of the microbial species or of humanity, of gradually destroy the world beyond it? (...) In this sense, it is perhaps permissible to interpret the history of humanity as an eternal struggle against the quasi-divine nature which, despite its resistance, is gradually, and by necessity destroyed by humans. "(Jean Baudrillard, Figures of otherness, p. 148-149, 1994)

But his fight to become "master and possessor of nature" is doomed to failure. For Gaia, if a species or a civilization were to disappear, it would not necessarily be a big loss but simply the failure of a civilization, unable to regulate itself, preserve its life support or overcome the vagaries of nature. . After the extinction of men, Gaia will continue on its merry way as if nothing had happened and will seek to recreate the conditions necessary for its balance.

"There was once a star on which intelligent animals invented knowledge. It was the most arrogant and deceitful minute in universal history: but it was only a minute. Scarcely a few sighs of nature and…the intelligent animals had to die."

Nietzsche, The Philosopher's Book, 1873

POST-CHAOTIC UTOPIA

You have just understood everything, and waking up is difficult? These trees cut with frenzy, these soiled seas without qualms, these exterminated species without restraint, this polluted atmosphere continuously... In short, this Earth which is yours is exhausted when it is absolutely not what you want: sustainable development is an honest solution to stop - or at least try to slow down - this sad phenomenon.

Like the house and the garden that you have long dreamed of and then finally been able to afford, that today you protect and maintain in the hope that they will remain in the family and that one day your children will benefit from them in turn, the planet is also your heritage... and that of 6.5 billion people. A gigantic co-ownership in short. And who would accept that we come and dump rubbish bins on his land, that we throw chemicals that would pollute the soil of his garden forever, that we remove the nest of swallows hidden under the roof? who ensures the annual return of these fabulous birds or that we cut down this beautiful apple tree which has been there for generations? Nobody of course. Yet this is what you experience every day at home... on Your Planet!

The definition given is very clear: "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet theirs". Thus, sustainable development implies not only respect for the environment, but also the reduction of social inequalities between men, that is to say solidarity with the poorest populations (that everyone can decently feed themselves, clothes, work, shelter, etc.) and cannot take place without a gradual transformation of the economy and society. A laudable idea that seems almost easy to implement on paper, but the reality is quite different...

Better manage the consumer society

Because the way of producing and consuming excessively has necessarily an impact on the environment even if we are not always aware of it. "Sedentary agriculture, diversion of waterways, mining, emission of heat and toxic gases into the atmosphere, commercial logging, genetic manipulation, are examples of the human intervention in ecosystems during development activities..." recalls the Brundtland report. Under these conditions, altering the air, water, soil, or living beings, is nothing more irresponsible than sawing off the branch on which we are sitting!

In the 1970s, a team of researchers working at MIT, in Boston, published an important work on the question of the myth of infinite and perpetual growth (The Limits to Growth - Club of Rome). Fifty years later, we see that the race of states, both communist and capitalist, towards a constant rise in GDP remains a daily reality (...) How to get out of this dynamic? How to manage a decrease, on a global scale, which would ensure that we would live in harmony with the true capacity of the Earth which hosts us? And to avoid chaos, famines and wars in search of natural resources from neighboring countries, shouldn't we start now?

Little equation. Simply put, GDP is the sum of consumer spending, government spending, private investment and the external sector (exports minus imports). If we associate decline and GDP, we see that there can be both a green transition and an increase in GDP (if the consumer buys an electric car rather than a combustion engine one, if he eats organic food, if governments direct their spending towards decarbonization, if companies invest in productivity gains and the reduction of their carbon footprint, etc.).

Moreover, earlier projections of inevitable downsizing tended to underestimate technological innovation and efficiency gains. A convincing example is the continual displacement of the achievement of peak oil, with all these discoveries of new sources of supply always more expensive to exploit or with the rise of oil and shale gas.

Voluntary degrowth is therefore a concept that challenges us in our overconsumption and in our consumption choices. It refers more to GDP per capita and invites each individual to reduce their GHG emissions balance from a fixed starting point. However, if it were possible to obtain a reduction of a certain percentage of this carbon footprint per person, this possibility remains if two people form a couple. But if this household decides to have one or more children, the percentage of each must increase in order to compensate. We are therefore talking here about a realism that is difficult to demonstrate and that must be put into a global perspective.

Voluntary decrease thus becomes a concept that comes up against the exponential increase in population from a state of overpopulation. And the required percentage mentioned earlier is likely to be rather out of reach. Its starting point today is the UN estimates published in December 2020 that, to meet the Paris Agreement's warming target, it would be necessary to reduce GHG emissions by 7.6% per year, each year, from 2020 until 2030. A target which would be, by far, an underestimate of the efforts to be made, according to the projections of Jean-Marc Jancovici. Last September, the French engineer, consultant and energy and climate specialist stated that, to respect the desired limit of increase far below 2°C, read 1.5°C, emissions must be divided by three by 2050, a decline of 5% per year for the next 30 years. "In other words, we would need an additional COVID-19 every year for 30 years to meet the objectives of the Paris Agreement," he explained.

Degrowth also calls on the Earth's biocapacity, which we are also exceeding at an exponential rate. According to environmental NGO WWF and think tank Global Footprint Network, the Overshoot Day from which humanity consumes more resources than the Earth can regenerate in a year was July 29 last year. Not to mention the accelerated depletion of non-renewable resources. On this basis alone, logic dictates that degrowth is inevitable anyway.

It has already been written that, according to a base scenario forecasting a rise of 2°C in 2050 and 3°C in 2100 in the absence of mitigation measures, and using the UN projections of a population exceeding 10 billion, the growth rate of fossil fuel intensity would cause the negative effect to dominate, reducing world GDP by 21% in 2100. Other studies quantify the potential effects over a closer.

In short, a long answer to conclude on a certain unrealism of voluntary decrease. And to invite reflection rather on a change of choice and behavior, individual and collective, accompanied by an approach borrowing from the circular economy.

The COVID-19 pandemic has revealed many flaws in our societies, and in particular in our economic model. The climate crisis, the aging of the population, the increase in inequalities have for years accentuated the pressure to change perspective.
The current economic model looks like a headlong rush. Extract resources, transform them, consume them, throw them away and start again. Simple, convenient, but it's the perfect recipe for waste, a one-way ticket to environmental destruction.
Despite cries of alarm, humans are still extracting more resources each year than the Earth can produce. We run towards a wall. How to avoid it? More and more governments, entrepreneurs, researchers and citizens believe that the answer lies with the circular economy, the aim of which is precisely the optimal use of resources.

Recycling is the best-known method, but "it's the last option", warns Daniel Normandin, director of the new Center for Intersectoral Studies and Research in the Circular Economy (CERIEC) at the École de technologie supérieure. "Recycling is when you have exhausted the other methods: eco-design, intensification of use, reuse, upgrading of materials, extension of useful life through repair or reconditioning" , he said. And there is the industrial symbiosis that links industries in the same region so that the residues of one can become the raw material of another.

Obviously, sustainable development is at all scales: global (applica-

tion of laws, creation of institutions) since it can only result from a collective effort, but also local (awareness, education) or even individual. Being generous, responsible, voluntary, respectful towards Nature and others, or 'consuming' in another way, also means acting for sustainable development. And "everything would be better if everyone took into account the consequences of their actions on others" correctly points out the UN document. However, it must be admitted that the possibilities of implementing effective actions depend very much on the means available to each country. "Poverty reduces people's ability to use resources responsibly; it intensifies pressures on the environment," the UN says.

"Carbon neutral by 2050." The objective is ambitious, but absolutely must be achieved to slow down and stop the train of climate change. Humanity is approaching the wall still too quickly. Other countries, cities and companies that have made the same commitment or even promised to do better are already at work. The climate problem is the only one for which we cannot push back the wall.

The disappearance of a single plant or animal can inevitably lead to the chain extinction of other species. At the end of this chain, the man. Our destinies are thus linked. The first objective of this new Nicolas Hulot Foundation campaign is to change our view of the living. We must learn to find our place in the heart of nature, we who have believed for too long that we occupy the center of it.

On the terrestrial scale, recent times have been dramatic for biodiversity. Pollution, reduction or deprivation of territories, blind exploitation of natural resources added to a thousand small attacks, have put the living universe on the threshold of a new great extinction of species, the first of anthropogenic origin. Its pace is 100 to 1,000 times faster than it would be without our tragic contribution. It is estimated that 50,000 to 100,000 living species are destroyed each year out of the existing 5 to 50 million.

The magnitude of the disaster is such that the mechanism of destruction is gaining speed over the mechanism of knowledge, since researchers have currently identified just under 2 million living animal or plant species.

The extinction of a species due to climate change can trigger a cascade of co-extinctions. A domino effect highlighted today by researchers who are interested in the future of flowering plants and their pollinating insects.
To determine the impact that global warming will have on biodiversity, researchers generally use climate models that consider each species separately. However, ecosystems are complex and the interactions numerous. To get a fairer idea, researchers are now trying to take into account the mutual dependencies of each other to better predict the future.

And according to evolutionary biologists from the University of Zurich (Switzerland), we can expect a greater impact of climate change on biodiversity than that predicted by conventional models. A conclusion they draw from the analysis of the interactions between flowering plants and pollinating insects in seven regions of Europe.

Some regions more at risk than others
Thus, there would be a 52% risk of seeing the sage-leaved cistus disappear by 2080 due to climate change. If this were to be the case, the little carpenter bee that feeds on its pollen could follow the same disastrous path. And take with it the myrtle that it also pollinates. Raising the risk of myrtle extinction from 38% to about 62%! It would also seem that some basins are more sensitive than others. For example, Mediterranean communities, generally more affected by climate change and whose distribution areas are narrower. A set of circumstances that weakens plant species in particular. Swiss researchers estimate that two to three times more plants than expected could disappear in the region by 2080.

The extinction of one species can lead to another...

By a domino effect, the extinction of one species can lead to others. Researchers show that there is more risk of cascading extinctions when no species comes to fill the hole left by the disappearance of another.

Human activities continue to cause the disappearance of species, to the point of causing the sixth mass extinction in the history of the planet. However, this loss of biodiversity could have dramatic consequences. Researchers at the University of Exeter (UK) made predictions by working on communities of plants and insects, including the parasitoid wasp Aphidius megourae. If they removed one wasp species from the ecosystem, other indirectly related species could disappear. "And because species are interconnected through multiple interactions, an impact on one species can also affect others." It all depends on the size of the food chain network in which the disappearing species is located.

Biodiversity loss increases ecosystem vulnerability
When a food web is complex, with significant biodiversity, one species can more easily replace another: there is less risk of cascading extinctions. On the other hand, if species disappear and the ecosystem becomes simpler, the remaining species are more vulnerable and the risk of further extinctions is greater.

The university press release also takes the example of predators: if the wolf disappears in a mountain range, large herbivores such as deer will be more numerous and will thus eat more plants. The vegetation will then be lacking to feed other species, such as rabbits or insects, which will then be threatened.

Half of the species could disappear before the end of the century
If nothing is done quickly, half of all living species could disappear before the end of the 21st century, say scientists gathered in the Vatican on the subject of biological extinctions. Their disappearance is irreversible, they recalled, explaining how useful they are to us.

"Our house is on fire and we are looking elsewhere," President Jacques Chirac declared in 2002 on the subject of climate change at the start of his speech before the plenary assembly of the 4th Earth Summit in Johannesburg. The sentence, which struck the spirits, would have been inspired by the lyrics of the famous song Beds are Burning by Midnight Oil: "How do we sleep while our beds are burning" (how can we sleep while our beds are burning? to burn). Fifteen years later, this assertion is more relevant than ever. One would be tempted to add: how can one sleep when half of all living species on Earth, animal and plant, terrestrial and marine, could disappear before the end of this century?

That's where we're headed for, if nothing is done

Services rendered by the large and also the smallest forms of life
A sixth mass extinction is underway for scientists and the damage promises to be as significant as that of the Permian-Triassic (nicknamed by the Anglo-Saxons The Great Dying), 252 million years ago. In the space of several tens of millennia, a global rise in temperatures had then caused the disappearance of almost all (95%) of marine species and 70% of terrestrial species.

Over the past two and a half centuries, human activities amplified by the industrial revolution have initiated a series of ecosystem degradations, deforestation, intensive agriculture, overfishing, poaching, soil artificialization, soil, freshwater and ocean pollution. Wounds to which is added a global climate change.

A few weeks ago, we learned that 60% of monkeys may have disappeared by 2060. In 2016, giraffes were added to the list of endangered species. Not to mention many big cats whose population is reduced to a few dozen individuals, elephants, rhinos, etc., all of which have become very emblematic species.

But, underline the researchers, many others, smaller, microscopic, are also in danger. They provide us with invaluable services. These

discreet species purify the air we breathe, the water we drink, enrich the land we cultivate. Some provide us with precious molecules for medicine, not to mention the food chain. All of this is in critical danger of extinction, scientists are alarmed.

How to stop these extinctions?
Faced with this sad observation, "the question is: how do we stop it?" questioned one of the participants, Paul Ehrlich. The researcher and other colleagues with him believe that birth control would be one of the solutions to the problem. "If you value people, you want to have the maximum number that you can sustain sustainably," he explained. For him, a population of around one billion would be the most sustainable for millennia. Recall that the UN projections count on 11.2 billion human beings in 2100. Moreover, if everyone adopt the current way of life of the United States, five planet Earths would be necessary.
"At the beginning of the next century, we will face the prospect of losing half of our fauna, said biologist Peter Raven. Yet we rely on the living world to live. It is very frightening. The extinctions to which we we face pose an even greater threat to our civilizations than climate change, for the simple reason that they are irreversible."

The man can be credited with reverse alchemy. While nature has succeeded, in a few billion years, in transforming chaos into elaborate and prodigious living things - biodiversity - it grants itself the luxury of generating the opposite phenomenon.

What are the issues ? Nothing less than the destiny of living beings, the future of biodiversity and, incidentally and jointly, that of the human community on this fragile planet. To think that the human species can manage on its own from this announced ecological disorder would be a monstrous error of assessment. Reducing biodiversity is in fact depriving oneself of as many chances of success for the future. The keys to the future are hidden in this huge reservoir. Medicine, agronomy, science in general feed on biodiversity, its principles and its genius.

Protecting biodiversity is not only protecting small animals, it is also and above all safeguarding the natural systems of the Earth which form the support of human life, water, soil, air... There are collective tools for protecting nature, but it is first and foremost our daily actions and choices that contribute to saving the planet. This fight, no one can delegate it to others, everyone must commit to it. It is the second objective of this campaign to encourage everyone to act, on their own scale.

BIODIVERSITY IN DANGER!
We all live from nature: it provides us with all of our food, more than half of our medicines and many other essential goods and services that we cannot reproduce. Biodiversity thus strongly contributes to the regulation of most natural phenomena and ecological services, including:

> The regulation of climates and the greenhouse effect
> Air purification
> Spring water production
> Replenishment of groundwater
> The decomposition and recycling of waste
> The formation of arable soils, the protection of soils against erosion and the maintenance of their fertility
> Maintaining biogeochemical cycles (atmospheric carbon fixation and oxygen production)
> The balance of the biosphere
> The supply of pollination agents and anti-parasitic agents...

The end of the 'law of the strongest': a utopia?
The consequences of our actions can indeed be dramatic, whether they concern energy (fossil fuels and minerals are not inexhaustible resources, let's not forget that!), biodiversity ("once extinct, a species is never renewed again..." we are reminded) or elements as precious for the survival of humanity as water or air. Therefore, it is

time for each state - and each individual - to become aware of its own responsibilities. Should the 'strongest' feel above the law in this area? No. Polluting or degrading the environment knowingly and even at the risk of putting the health of the population in danger under the pretext of financial stakes must be severely punished...!

This sentence from the Brundtland report is topical: "an industrial company can very well afford to pollute the air or water in an unacceptable way, simply because the people who suffer from it are too poor to take legal action. will be able to completely destroy a forest by cutting down all the trees, simply because the inhabitants have no other options or because the companies are more influential than the inhabitants of the forests". Preventing such excesses requires giving significant powers to the competent authorities, so that they are not subject to any pressure from the most influential people or states. Sustainable development, a utopia? Certainly not, because attitudes are changing for the better. Today there are reasons to be optimistic and to think that sustainable development has a bright future ahead of it!

The more diverse an ecosystem is, the more productive it is, the more stable it is and the faster it recovers after a natural disaster, drought or storm, for example. Ecosystems that are too degraded therefore end up no longer fulfilling their functions and the services they provide to human societies. Man has always modified the environment for his benefit by considering it as an inexhaustible resource. Wrongly.

Weakened, nature is unable to adapt its rhythm to the brutal changes imposed on it by man. If things remain as they are, we risk diminishing biodiversity on the planet for millions of years to come, inevitably leading to a reduction in the possible development choices for future generations.

According to an international study published by the magazine "Nature" at the beginning of 2004, 25% of animal and plant species could disappear before 2050 because of global warming. The impact of human activities is such that the rate of extinction of species has accelerated by 100 to 1,000 times, leading to an impoverishment of life that prefigures the 6th wave of extinction comparable to the last known, 65 years ago. million years, which caused the disappearance of the dinosaurs, but at an unprecedented speed.

Only one planet

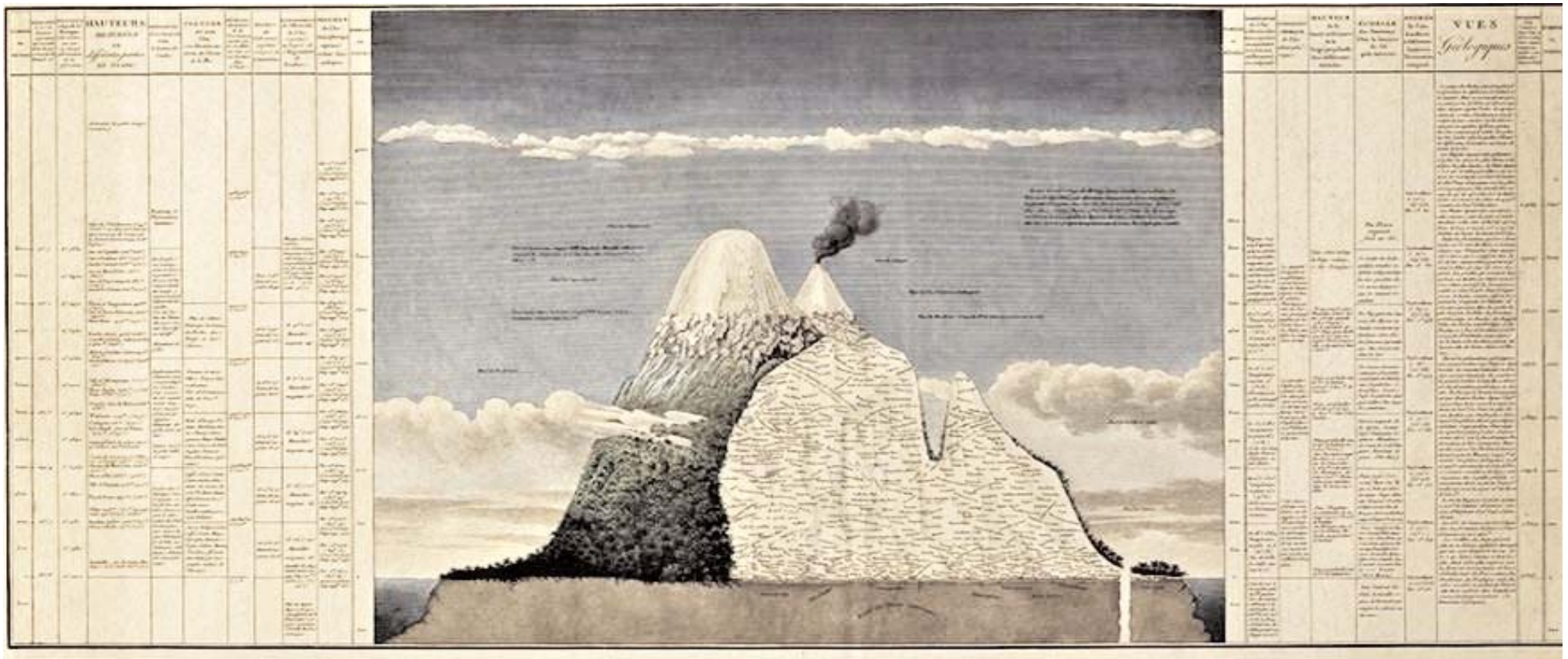
For Humboldt, the general equilibrium of the planet is the result of an infinity of balancing mechanical efforts and chemical attractions. Describing the Earth as a dynamic physiological system in perpetual evolution, it anticipates by more than a century the Gaia hypothesis formulated by the English climatologist James Lovelock in the 1970s. He understood very early that if the Earth is a single organism and interconnected, it could be catastrophically damaged by human activities.

A true prophet of the Anthropocene, Humboldt lists the three ways in which the human species influences the climate: deforestation, excessive irrigation, and the "great masses of steam and gas" generated by industrial activities.

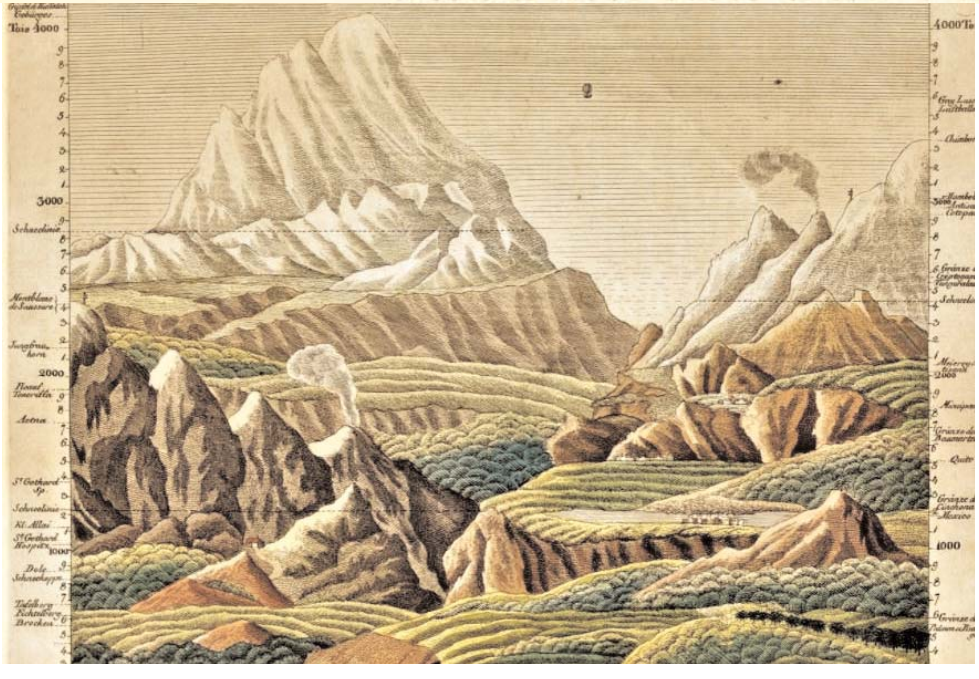
A worthy heir to Humboldt's theories, George Perkins Marsh published in 1864 the book Man and Nature, or Physical Geography Modified by Human Action. The more pessimistic original title, '"Man as a disruptor of natural harmonies", was refused by its publisher who feared that it would harm sales...

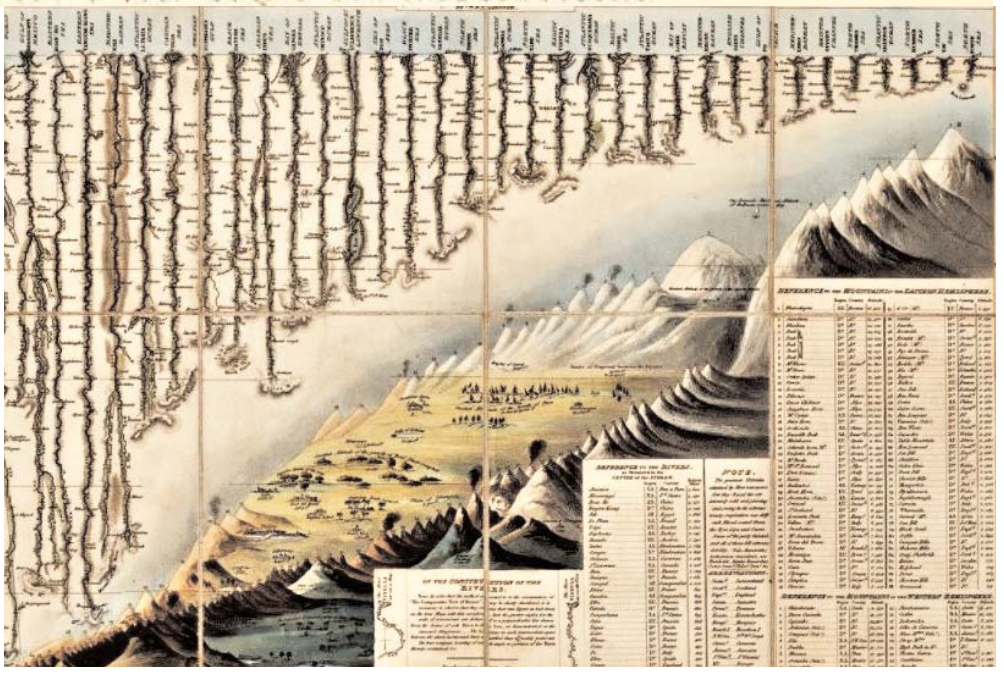
In this work, Marsh, like Humboldt, again insists on the fact that all the elements of nature are connected. He evokes the disasters of deforestation, explaining the importance of the invisible ecosystem services provided by forests. Thus, according to him, the more the forests disappear, the more the soils become impoverished, the more the biodiversity decreases and the more the climate changes.

Man and Nature denounces the misdeeds of economic and industrial omnipotence. The book tells "a story of destruction and greed, extinction and exploitation, depleted soils and torrential floods."



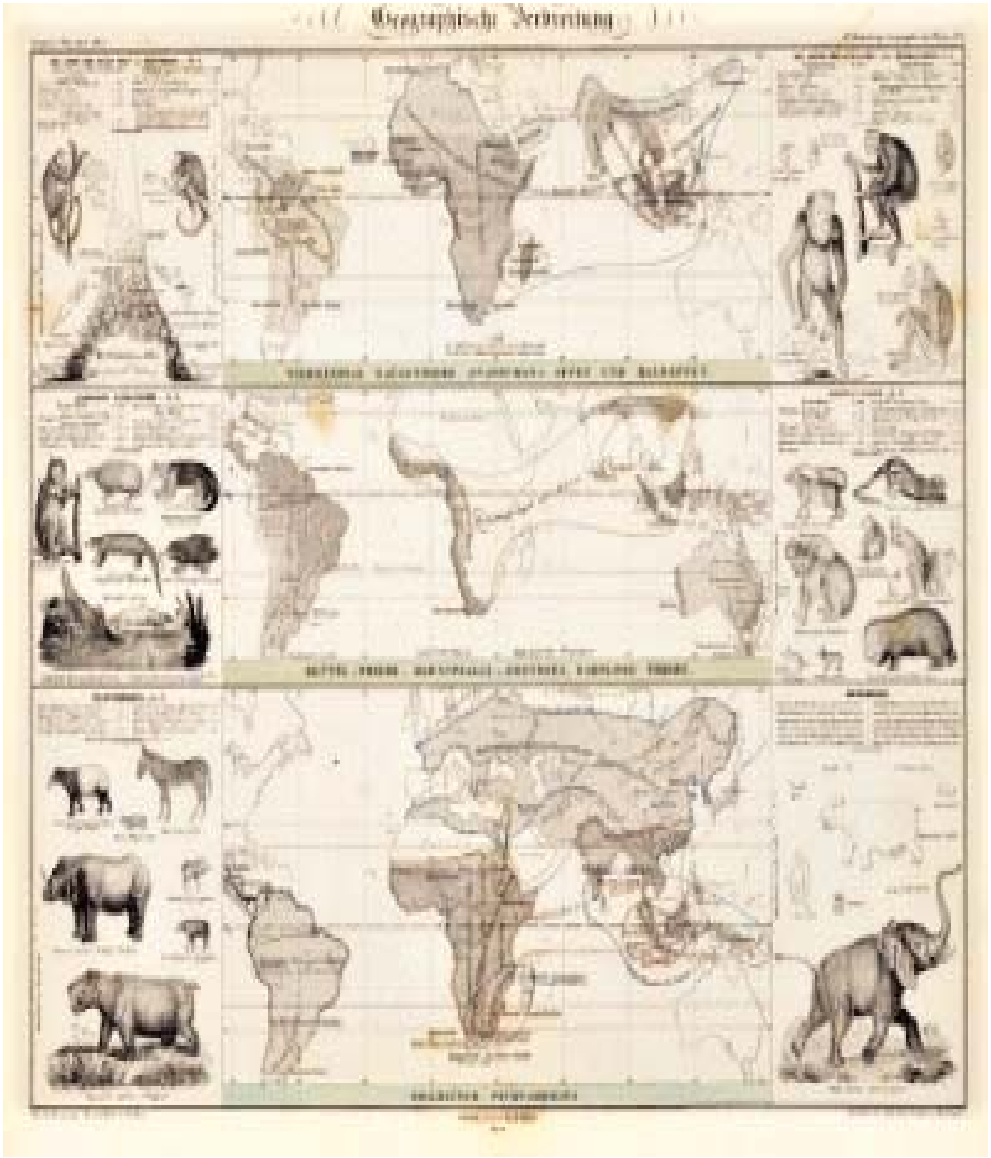
GÉOGRAPHIE DES PLANTES ÉQUINOXIALES.





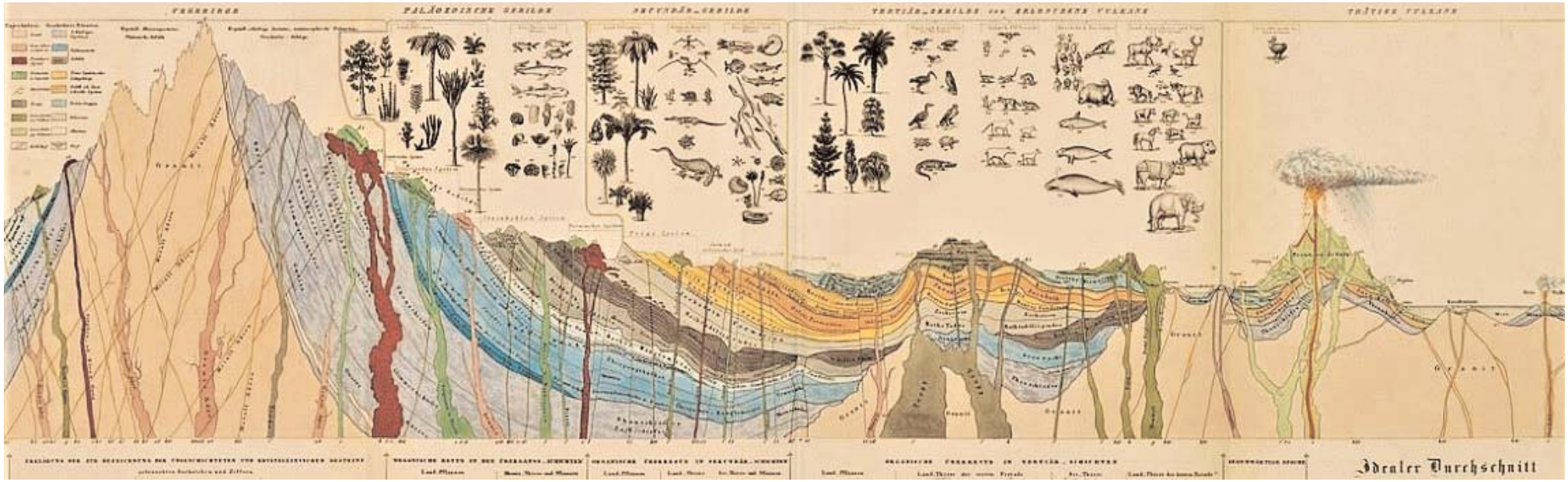
Glimpses of plant geography

This map is a simplified illustration of the geographical occurrence of plant species and is entitled "Outlines of Plant Geography, containing: 1) the distribution of plants according to the main relationships. A. von Humboldt's statistics on plant families and the most distinguished groups of plants the twenty-five phytogeographical empires of J. Schouw Range of the family of palms, of the genus spruce (Pinus) and of the genus heather (Erica) - 2) Distribution of plants in the vertical direction in warm regions, temperate and cold zones etc. - 3) Ratio curves of mono- to dicots in the Swiss Alps - 4) Graphical statistics of excellent plant families - 5)



Geographical distribution of animals

This world map attempts to capture and geographically assign the animal world in a single map and is titled "Three Maps for an Outline of the Geographical Distribution of: A. Four-Handed Mammals, Quadrumana: Monkeys and Half-Monkeys. B. Beeches, Marsupialia and toothless animals, Edentata C. Pachyderms, Pachydermata [Kosmos I: II, i pp. 178-188]



Ideal average of the formation of the earth's crust

This profile section is an idealized illustration of the plant and fossil deposits of past geologic ages and is titled 'Ideal Average of a Portion of the Earth's Crust. Written by Thomas Webster FGS etc. Plants and Animals According to Selection and L 'Arrangement of Dr. Buckland, Drawn by Joseph Fischer.' [Kosmos I: II, af p. 79-157]

Geographical distribution of human races

This historical map classifies human ethnicities according to their geographic distribution and is titled "Geographical Distribution of Human Races. Outline of Food and Population Density in Arable Countries and Selected Elements of Human Physique." [Kosmos I: II, i p. 178-188]

How to order the chaos in a TERRESTRIAL whole?

How does chaos theory apply in our daily lives?
The chaotic constant of nature is omnipresent. You will have understood that it applies to dynamic systems, whose components are in interaction.

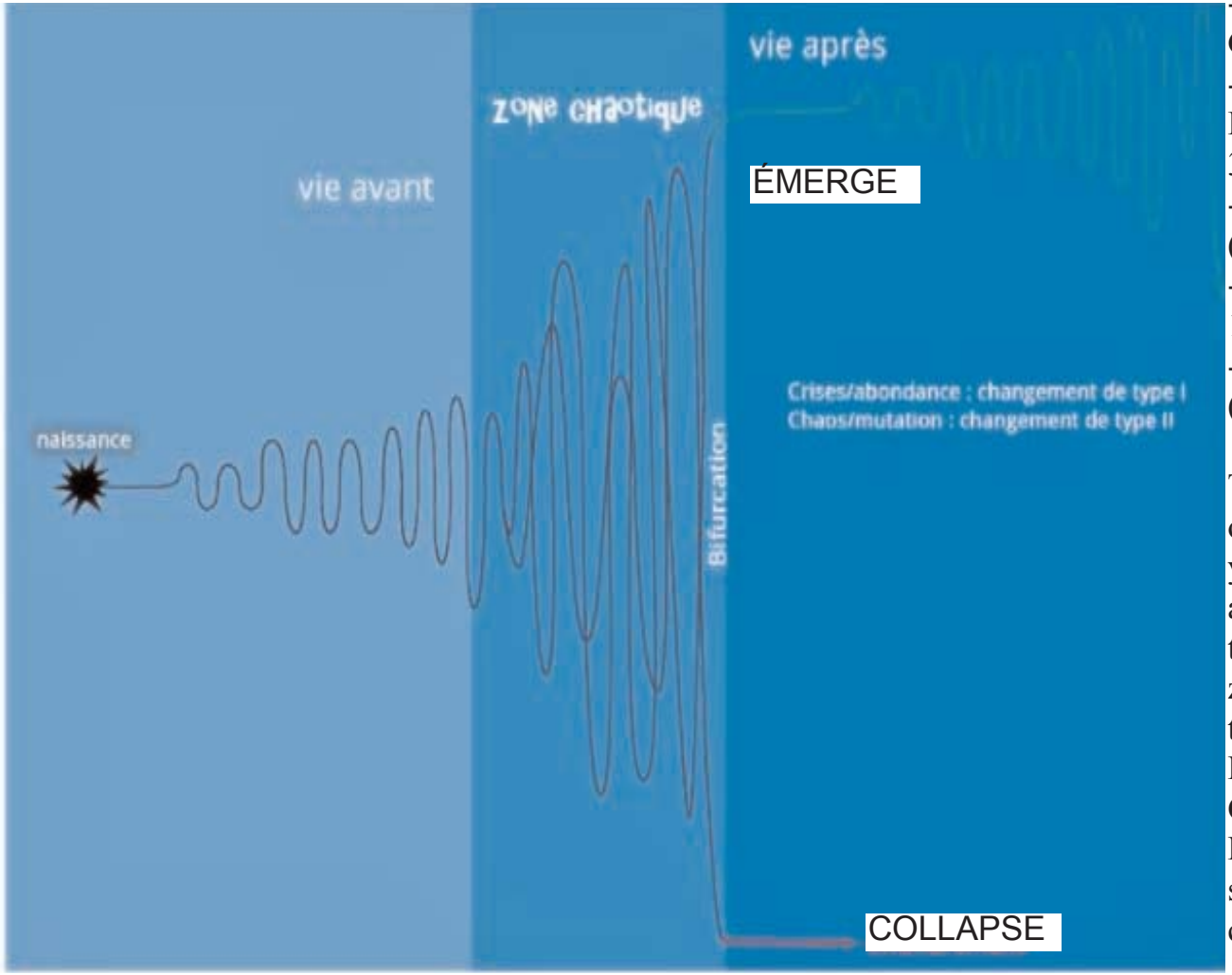
GAIA is a dynamic system in its own right, in which the human being is one of the components. Remember this invariability of motives according to the scale of observation that one uses. It also applies to the evolution of our society. Humanity and the human being are just two different scales of observation.

This repeated pattern is as follows:
Before the chaotic period, life takes place in a phase alternating periods of prosperity (for example), with periods of crisis, … and vice versa.

Then, can come the chaotic period. In any case, entering this phase is irreversible (Second thermodynamic principle). At the exit there will be a fork. If it is positive, we will speak of Emergence, otherwise, we will speak of Collapse.
In case of emergence, that is to say a positive outcome after the chaotic phase, life will be "better than before", different and in any case, more complex, richer, explained by the theory of chaos.

In the history of Humanity, civilizations follow cycles, passing through these stages of mutation, the outcome of which is collapse or emergence. Civilizations are born, grow, until internal or external frictions, collapse and transform, without completely disappearing.

Europe has experienced different cycles, according to a given scale, approximately every 550 years:



- the invasion of the Greek cities (150 BC)
- the fall of the Roman Empire (around the year 380)
- the feudal mutation (around the year 920)
- the rebirth (around 1450)
- our modern world (20th century)

The use of another scale of approximately 9000 years, offers an identical and different reading at the same time. This zoom level designates the sedentarization of Man in the Fertile Crescent of Mesopotamia as the starting point of a new cycle of Humanity.

And today ?
In a world where individualism and consumption cause inequalities, tensions, pollution, etc. (cf COP 23: the reasons for a foreseeable failure) Crises follow one another. The planet is dying. A collapse is not far off. As a number of scientists and futurists have said, we are in a period of change. What will be the outcome? Emergence or collapse? What is certain is that according to the science of chaos theory, we are in an irreversible momentum.

Demography versus ecology
Take the chaos caused by the environmental crisis due to human economic activity coupled with that caused by the demographic crisis due to overpopulation which consumes more energy and food than Gaia can produce.

To overcome the threat of overpopulation, the environmental chaos due to global warming will lead to a considerable increase in the mortality of species, mainly the human race.

"Man exterminates animals so quickly that nature will take millions of years to recover"

This exponential mortality will help to temporarily reduce the impact of man on the environment. For maximum impact of population reduction, the human race will have to learn to self-regulate. If the environmental chaos persists, it is because man has failed to choose the right relations of choice allowing him to properly order, to synchronize two extreme chaotic systems. This failure will ultimately contribute to the mass extinction of the human race.

Thanks to topological synchronization, the researchers succeeded in extending the study of synchronization to the extreme cases of chaotic systems which present themselves with very different parameters.
Chaos is a real challenge to physics. He is unpredictable. Out of control. However, researchers seem to have pierced one of its secrets. They think they have figured out how to bring some order to it. Chaos! For ordinary mortals, it is synonymous with confusion and disorder. Physicists have a very precise idea of this. A chaotic system behaves, according to those who study it, like a random system. Although it follows deterministic laws, its dynamics are still bound to change in a totally erratic way, but researchers have discovered that sometimes chaotic systems synchronize.

All liberation is chaotic.

Physics is based on the assumption that the Universe has laws, and its whole ambition is to find them. From this point of view, there is therefore no disordered system: all systems all have an order, laws that describe them. On the other hand, it is quite obvious to everyone that there are "complicated" systems, endowed with too many factors for us to be able to take them all into account and make precise prediction calculations. These systems appear disordered.

Chaos theory demonstrates the existence of particular combinations of order and disorder, measures this degree of irregularity through fractional geometry and represents, through the computer, the fractal image of chaos. All sciences, including social ones, are concerned, to respond to Plato's intuition reformulated by James Gleick: "(...) behind the visible and particular forms of matter must hide ghostly forms which serve as their model. invisible." So much so that the disorder of matter, of forms, of the world is only apparent disorder. It is only after the fact, only after the storm, that one can see that the evolutionary development is perfectly coherent. The regulation of the system brings us back to auto poieis.

"There was light and order was freed from disorder".

This famous verse of Milton inspired by Genesis inevitably brings us back to Prigogine's work on chaos. It was he who reversed the famous principle of thermodynamics that "the universe is in perpetual struggle against the irresistible rise of disorder." On the contrary,

Les deux notions d'Égalité	Logique correspondante
Identité : Type « A = A » 0 = 0, 1 = 1 2π = 2π mais JAMAIS 0 = 1, 0 = 2π	**Negation** Alpha ≠ Omega 0 0 0 ω 2π 1 -∞ +∞ Vrai / Faux 1 / 0 A NON-A *Logique Négative*, Continue, Statique, LINEAIRE, celle *d'un Univers NON-TOTAL*
Équivalence : Type « A = B » 0 = 0, 1 = 1 2π = 2π mais aussi et SURTOUT 0 = 1 ! 0 = 2π !! 0 = ∞ !!!	**Alternation** Alpha = Omega ! 0 = ω 0 = 2π 0 = 1 0 = ±∞ A B A≠B ET A=B ! Vrai / Faux 1 / 0 A ⇔ NON-A ! *Logique Alternative*, Cyclique, Dynamique; Logique FRACTALE, *celle de l'Univers TOTAL !*

he demonstrated that life is none other than the history of an increasingly higher and complex order underlying the apparent chaos of matter. Chaos being only a necessary and transitory instability towards the order thus confirming the theorem of Zermelo that any system comprises relations of choice which make it possible to order it well.

According to mainstream physics, there is an irreversible process in the cosmos called entropy which involves an ever-increasing process of disorder. The entropy defined by the degree of disorder increases irreversibly. Prigogine's work on chaos demonstrated that, on the contrary, the irreversibility of entropy is possible. Again we must appeal to paradoxical thinking, according to Prigogine "non-equilibrium is the source of order; chaos produces order."

Thus increasing disorder implies the creation of a new order. One could even think, theologically speaking, that Prigogine resolves the famous fight of the Sons of Light against the forces of Darkness, so dear to Zarathustra. Philosophically, one can even argue that the question of evil as disorder only arises in periods of chaos as the absence of good. We are thinking here of Seneca who writes in one of his Letters to Lucilius: "What is Good? The knowledge of reality. What is Evil, its ignorance". This misunderstanding of reality can lead the free being to turn this freedom against himself.
Since Prigogine's statements, we have witnessed a "re-enchantment" of the world, a "re-sacralisation" of nature marked by a new discourse which "rationally" reformulates the old cosmologies which have known how to preserve the links which unite the living universe, earth to heaven, man to the cosmos.

It will be up to the natural philosopher Von der Weltseele to conclude in these terms: "nature is the visible spirit, the spirit, the invisible nature", such is "the soul of the world".

All thought is contingent on a metaphysical premise including scientific logic. Everything is language, the atom, like the letters of the alphabet, is the language of the Universe (Leucippus), the Universe is musical language (Pythagoras and Kepler), the Universe is mathematical language (Copernicus, Galileo and Einstein). In fact all join the metaphysical aims of Anaxagoras (610-547 BC) who then proposed intelligence as the principle and organizing force of the Universe that quantum physics describes as "primordial information". Thus this diversity of levels of consciousness common to all species down to the smallest particles therefore forms a Unity specific to the entire Universe. We can take up this word from Plato:

"nature is an enigmatic poetics (poïesis)".

For not only is nature alive, but man also has the particular faculty, thanks to the logos, of transmuting the knowledge of life into a spiritual experience; what the Theosophist Joseph de Maistre called "the Revelation of Revelation."

In 1904, the great mathematician Ernst Zermelo formulated a theorem considered the crowning achievement of modern mathematics and of all set theory:

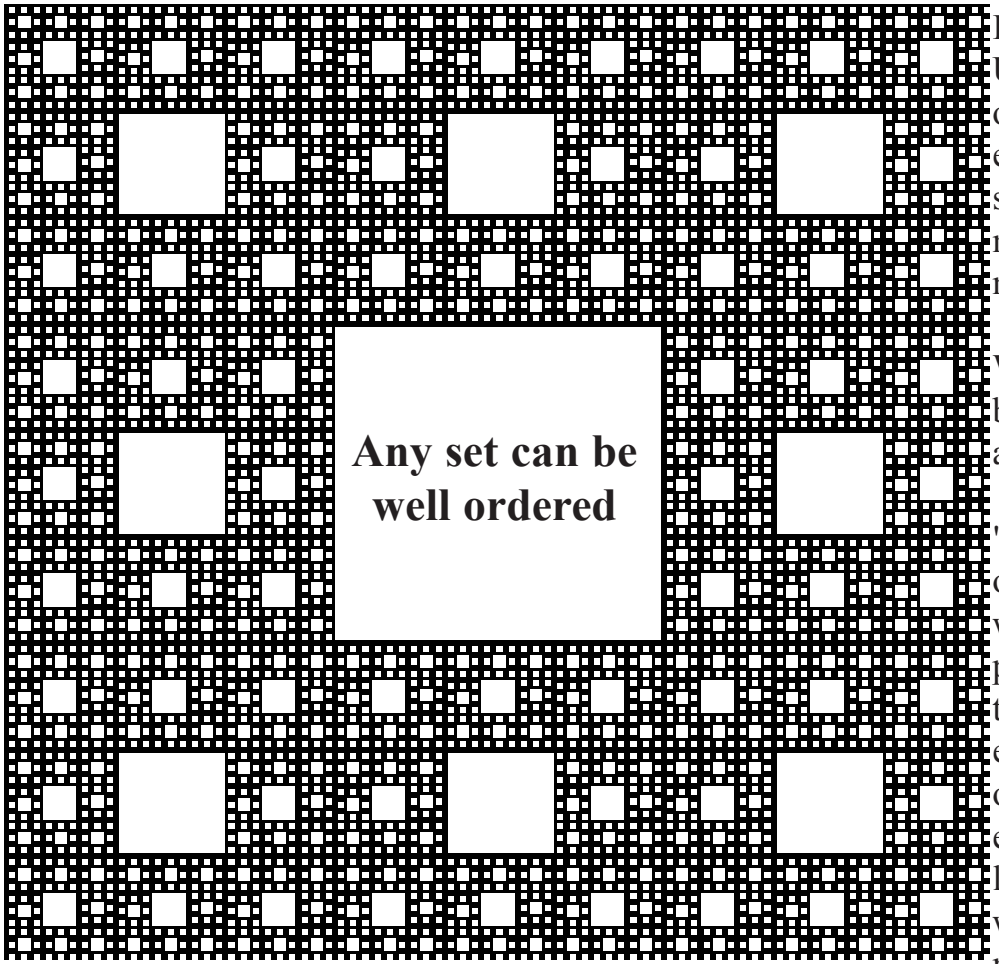
"Any set can be well ordered"

"What Zermelo demonstrated is that any set whatever it is has a relation of choice allowing the totality of the elements of the set to be well ordered. This is a result of great significance, because it is applies to all sets...and therefore to the set of all possibilities, that is to say to Being as well as the Universe". (Charon, The lights of the invisible, 1985, p.122-123)

Thus our body, our reason has the relation of choice making it possible to be ordered with the great laws of the universe but also has a choice of relations which can disorder it. Lack of understanding of the great laws of the Universe, of life and of nature is equaled only by ignorance of our planet, of its ecosystem, ultimately of our own body. Pollution, among other things, becomes the expression of a

bad choice of freedom preventing from properly ordering all the elements of the whole.

The characteristic feature of the first peoples is the conception of the body as a miniature replica of the cosmos in direct communion with the surrounding nature. The body is the bearer of meanings revealed by ornamentation, the cosmetic of the Greek "kosmeticos", which "consists therefore in clothing oneself with cosmic qualities", in becoming, in a way, "in conformity with the cosmic order". . The primitive body paintings and the dance/trance express a cosmic wisdom inscribed in the body in harmony with the rational intelligence of nature.



Thus the Universe is a continuous creation of primordial information, of the order of the spirit materialized in the living as primordial sensation, order of nature.

Thus, as Pascal thought, nature as "infinite in flesh and bones", is the "spirit in action" and man, both body and spirit, because free and conscious is capable of progressing indefinitely in the domain infinity of knowledge. Man will never be outside of nature since the essence of nature is at the heart of man; nature, like man, is unfinished. (Conche Marcel, Philosopher ad infinitum, PUF, Paris, 2005, p. 130-161)

Anaximander has already seen the essential of nature: that it is unfinished. there is only it, but yet an open infinity, since it is nothing other than continuous creation. 'infinite, whichever way one turns' (Vors. 12 A 17) - only successive and succeeding each other in infinite time, some begotten, others destroyed: and this can have no end, says Aristotle (explaining Anaximander's position), "because the generations and the destruction of the worlds necessarily suppose movement, which will always exist" (Phys., VIII 1, 250b 20-21 in Conche, 2005, op. cit. p.160)

In summary, the evolution of the Universe, of nature including our own, is not over. Bergson's creative evolution published in 1907 demonstrates that creation is not synonymous with beginning but with continuity.

We are becoming autopoietic, driven by a perpetual movement of creation.

"It is no longer a terrestrial problem, or only terrestrial. We are dealing with processes of increasing complexity, of memorization, of integration, which we find absolutely everywhere, and at all times; at the origin of the life, throughout the evolution of life, but also before life. We can go back as far as we want: there are no atoms if we do not integrate quarks; there is no there are no molecules if there is not the diversity of atoms, and the integration of these atoms into more complex structures; there is no single-cell stage if there is not the diversity and integration of complex molecules, RNA, DNA, enzymes, etc.

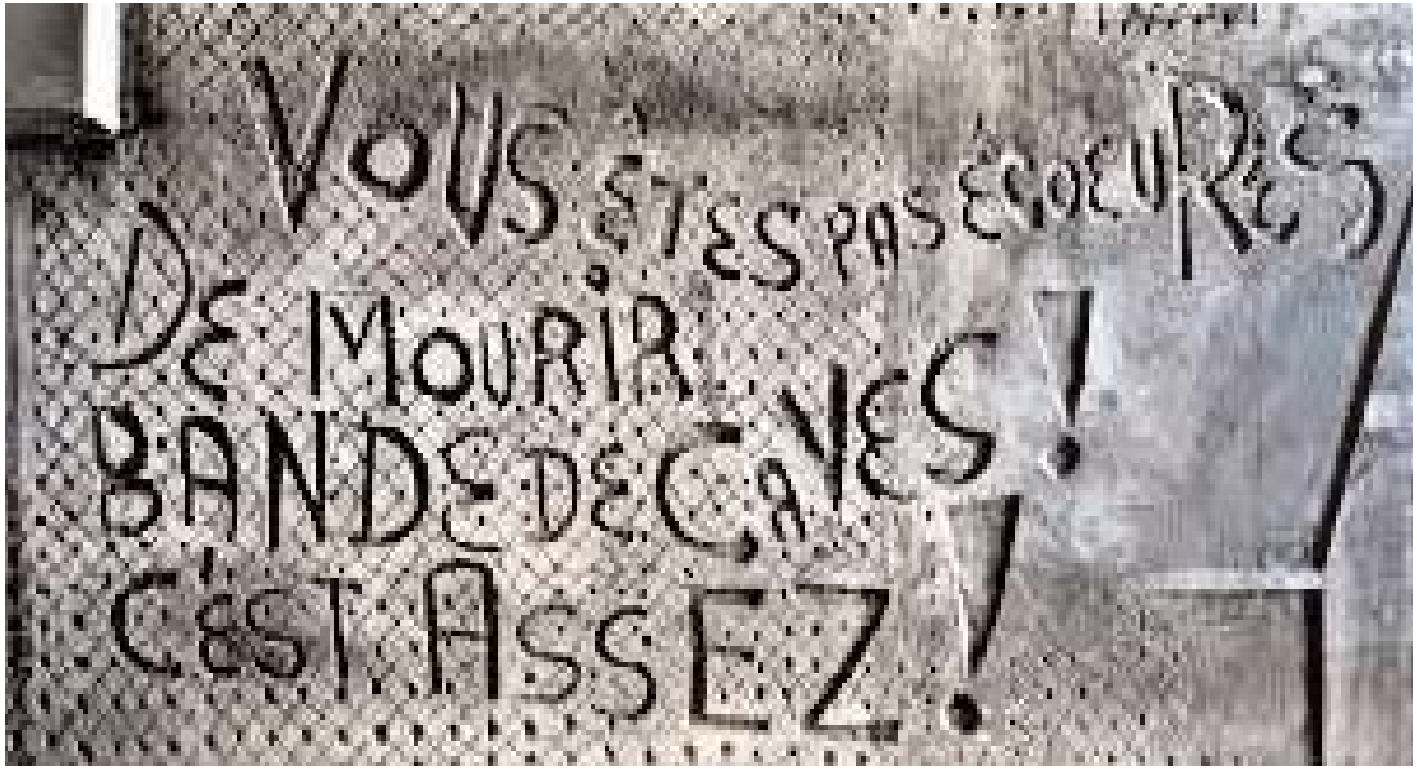
To put it briefly, the omnipresent process in the Universe, both inert and living, is the integration of diversities into a dynamic structure which has the genius to be able to generate the memory of its own construction. It is absolutely fabulous! However, we ourselves come under this logic which consists in reintegrating an old memory. No doubt evolution also requires a diversity of memories. Two or more memories meet, fertilize and integrate, recognize each other in their diversity, and a new memory can then emerge.

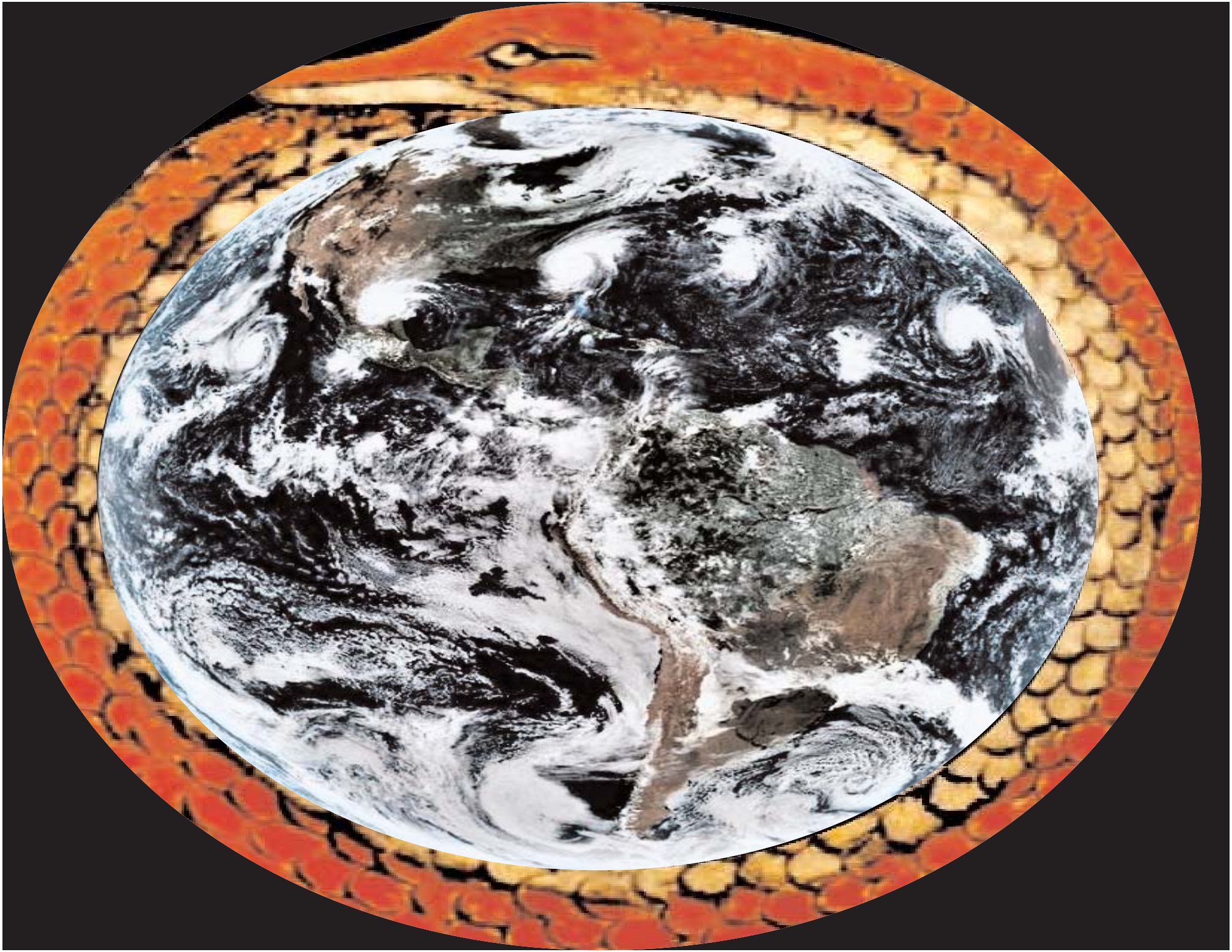
"The visible world only becomes the real world through the operation of thought" (Gleizes, Metzinger)

Human history is shot through with such fundamental discovery that it often closes eras. Thus the scientific discovery of Copernicus (1543) which revolutionized the astronomical system by placing the sun at the center of the Universe marked "the end of the Middle Ages and the beginning of modern times, because, much more than the conquest of Constantinople by the Turks or the discovery of America by Christopher Columbus, it symbolizes the end of one world and the beginning of another. " (Koyré).

In Structures of Scientific Revolutions, the historian of science Thomas Khun recounts that in addition to the normal process of accumulating knowledge and discoveries, all civilizations were, at some point, propelled into a new dimension of reality that challenged question the foundations, the cognitive frameworks and even the ideological context which until then made it possible to make the world and society intelligible. These moments of transformation which Karl Jaspers call "axial epochs" are characterized according to Khun by paradigm shifts which constitute the intellectual framework of a new field of knowledge. Another important characteristic is that the paradigm shift is taking place, rather revolutionizing all sectors of human activity, be it science, art, politics or religion.

It took us twenty-five centuries of Western philosophy, of scientific method to understand the metaphysical respect for all living beings by primitive peoples. Modernity will therefore have created scourges "which arise from man's claim to acquire superhuman knowledge in the name of which he becomes inclined to exercise over others an omnipotence that cannot be disputed." Will we have the collective wisdom to curb our desire for domination to the detriment of nature?





GAIA SOURCE

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